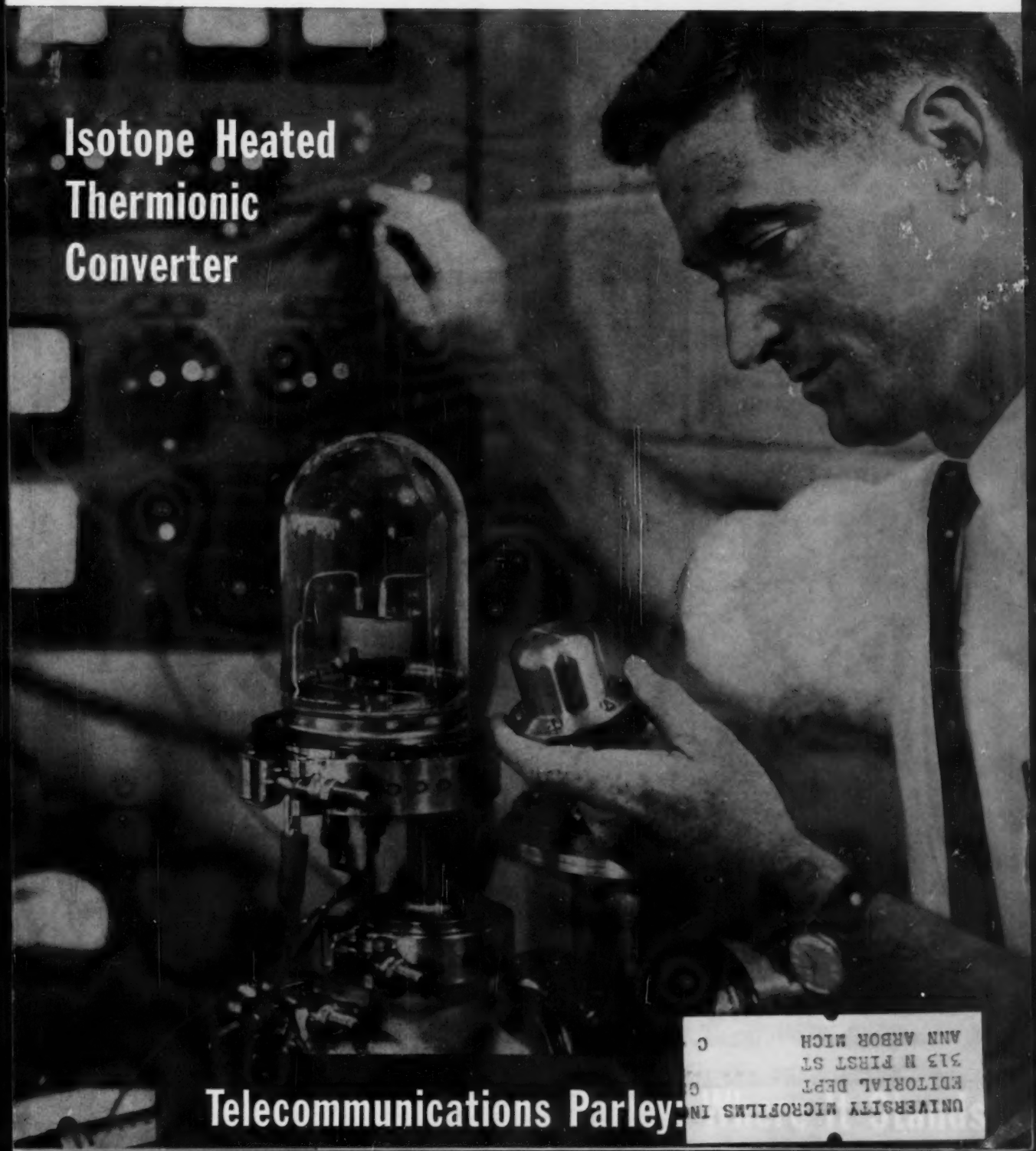
NOVEMBER 13, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 46 PRICE SEVENTY-FIVE CENTS



Isotope Heated Thermionic Converter

Telecommunications Parley:

UNIVERSITY MICROFILMS INC
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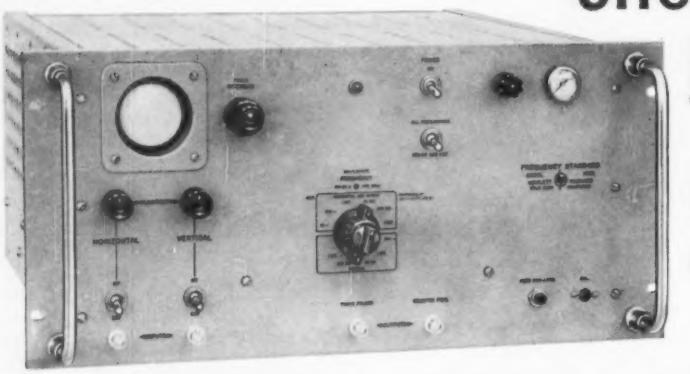
New, *compact* PRECISION FREQUENCY STANDARD

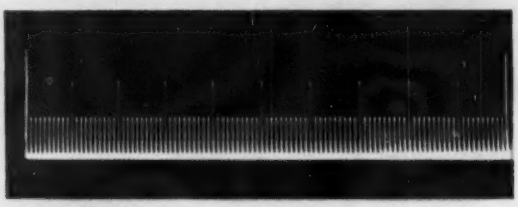
offers $5/10^8$ stability, just 8¾" high



hp 100ER

FREQUENCY STANDARD

Model 100ER offers six standard sine and four rectangular frequencies in decade steps; available simultaneously and selected on front panel.



Timing comb output pips occur at 100, 1,000 and 10,000 microsecond intervals. Timing comb simplifies "fast" measurements and calibration.

Specifications

Stability:	$5/10^8$ parts per week, $3/10^8$ short term.
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Output Voltages:	Sinusoidal 5 v rms min.; rectangular approx. 15 v peak. Harmonics to 5 MC obtainable.
Rated Load:	1 MC and 100 KC, 50 ohms nominal; 10 KC, 1 KC, 100 cps, 10 cps, 5000 ohms nominal.
Distortion:	(Sinusoidal) Less than 4%.
Frequency Adjustment:	Screwdriver tune adjusts 1 ppm.
Size:	8¾" high, 19" wide, 18" deep behind panel. Weight 35 lbs.
Price:	$900.00.

Data subject to change without notice.
Price f.o.b. factory.

This compact, highly convenient new hp frequency standard not only provides stability equivalent to complex, expensive primary standards, but offers the versatility of a wide variety of outputs. Signals available include six standard sine frequencies and four rectangular signals which may be distributed by 50 ohm cables for use at many different stations on a production line or in the laboratory. A particularly useful feature is a timing comb for calibrating, and for measurement of sweeps and time intervals.

Stability of 5 parts in one hundred million per week is assured by careful aging and testing of the crystal controlled oscillator and oven.

Model 100E includes a built-in oscilloscope which may be used as a comparison device to calibrate external equipment such as oscillators through use of Lissajous figures. The scope may also be used to check internal frequency deviation of the instrument.

For complete details and demonstration, see your hp representative or write direct.

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electronics

NOVEMBER 13, 1959

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Vol. 32 No. 46

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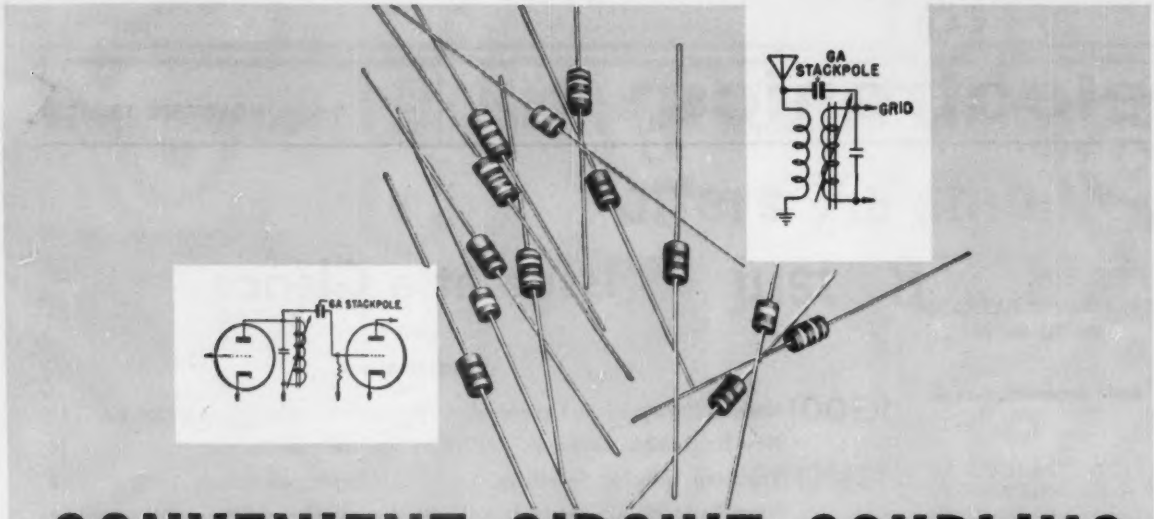

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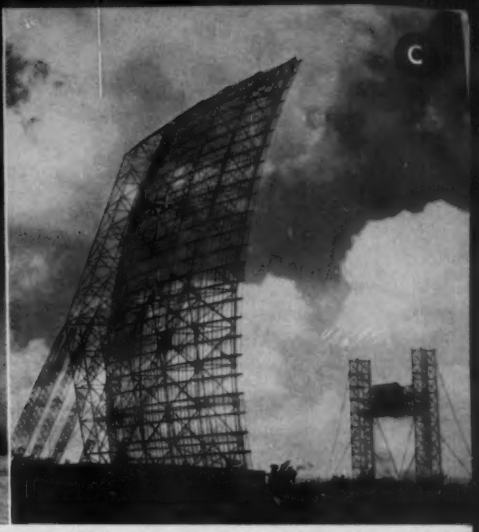

ANTENNA PROBLEMS?

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A TRACKING ANTENNAS — *A 60-foot satellite tracker points skyward. 28- and 84-foot models also available.*

B SCATTER ANTENNAS — *One end of a scatter link showing two 120-foot antennas. 28- and 60-foot models are also available.*

C RADAR ANTENNAS — *A giant radar antenna forerunner to the BMEWS Program. Dozens of conventional types are also available.*

D RADIO TELESCOPES — *An 84-foot radio telescope listens to the heavens whisper. 28- and 60-foot models are also available.*

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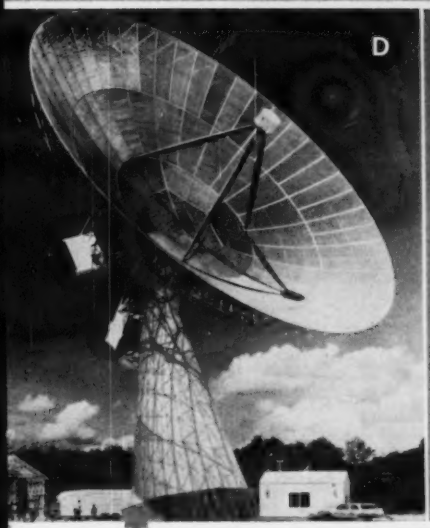
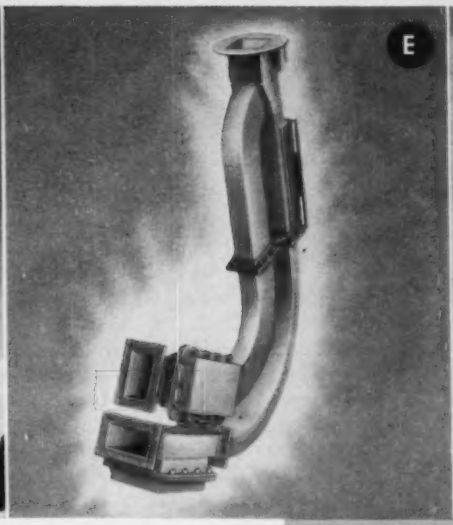
F FIELD SERVICE — *Kennedy Field Service engineers erect an 84-foot radio telescope. Other services include site selection, construction, personnel training and servicing.*

G RESEARCH AND DEVELOPMENT — *Kennedy's antenna service includes basic R & D in microwave propagation.*





THE solution to antenna problems begins when someone says: "Let's ask Kennedy!"

A few of the many reasons why are shown on this page. These Kennedy antennas are setting new standards for all-weather reliability and versatility wherever they serve throughout the free world.

Kennedy antennas come in many shapes and many sizes. But whatever the type, and whatever the conditions under which it must serve, Kennedy can offer a design that fully measures up to specifications.

Kennedy Field Service engineers are available to install antennas anywhere in the world. It's a part of the complete, integrated service that is still another reason why more and more people in electronics are "asking Kennedy" about antenna problems.

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SHOPTALK . . . editorial

AIR TRAFFIC CONTROL. A member of our staff recently got a first-hand lesson in the need for effective air traffic control.

He was flying to the Naval Air Station, Oceana, Va., to get the radar traffic control story on p 54. During his trip along the busy New York-Washington airway fully half the flight time was consumed in holding, or flying around in circles awaiting permission to enter controlled air space.

One holding pattern had the plane circling the Federal Aviation Agency's National Aviation Facilities Experimental Center near Atlantic City, N. J. Down below, work was in process that offers hope for solving growing air traffic control problems. Testing of new air-traffic systems is proceeding as fast as systems come out. Col. Bill Cowart, chief of NAFEC, says his center is "meeting all commitments," points out that there is no backlog of untested systems.

Among other chores, the center is now studying USAF's latest radar control system, an FAA height-finding radar, new-model airport surveillance radars and a new electronic landing system. FAA installed a Decca navigator chain a couple of years ago in the New York area. Now the agency is employing the system to develop new navigation methods for low-altitude work, especially for helicopters.

In the continuing air-traffic debate there are two extreme philosophies. One says "wait for the perfect system and then put it in all at once;" the other says "put in everything right now that will help at all." FAA's philosophy espouses neither extreme.

FAA's policy is one of deliberate speed in the testing and evaluating of all possibilities. In the long run it should produce a good system for the national air safety.

W W MacDonald

EDITOR

Coming In Our November 20 Issue . . .

MICROWAVE COMPUTER CIRCUITS. Economic pressures push computer technology into a perennial pursuit of higher speeds. Up to now, faster components have been aided by novel programming approaches and new circuit techniques (ELECTRONICS, p 39, May 1). But from here on, major breakthroughs will be needed for significant advances in speed. Two principal avenues of research for the immediate future are cryogenics and microwave components, the latter being the more immediately realizable.

Next week, Associate Editor Leary summarizes some of the more promising microwave techniques in computer applications. His article is a capsule version of a symposium on microwave techniques sponsored earlier this year by the Office of Naval Research. Work described was reported by Bell Laboratories, General Electric, IBM, RCA, Sperry Rand and the University of Illinois.

MISS-DISTANCE INDICATOR. Keeping score on missile performance requires a way to measure the distance a missile misses the target drone. W. H. Doty of the Electronic Specialty Co. in Los Angeles describes a low-cost active radar for measuring this distance.

INFRARED CALCULATIONS. Design work on infrared systems can be speeded by simple methods of determining the system characteristics required for a given range. Texas Instruments' C. S. Williams and J. J. Redmann use a simplified range equation to construct a nomogram relating range, source size, detector signal-to-noise ratio and area of detector entrance pupil.

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TYPE	MINIMUM PEAK REVERSE VOLTAGE (Volts)	MINIMUM FORWARD BREAKDOWN VOLTAGE (Volts)	MAXIMUM AVERAGE FORWARD CURRENT (amps) at T case = 100°C	MAXIMUM AVERAGE FORWARD CURRENT (amps) at T case = 25°C
TCR 102	100	100	10	20
TCR 202	200	200	10	20
TCR 302	300	300	10	20
TCR 402	400	400	10	20

Maximum Storage Temperature Range — 65°C to +150°C
Maximum Operating Temperature Range — 65°C to +125°C
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Transitron's Silicon Controlled Rectifier is a PNPN high power bistable controlled switching device. It is analogous to a thyratron or ignitron, with far smaller triggering requirements and microsecond switching. The low forward voltage drop permits high current ratings and provides high efficiency with low cooling requirements. The PNPN design permits higher voltage ratings and lower saturation resistance than power transistors. This permits the smallest packaging for high power control yet made possible.

Ratings currently available extend to 10 amperes at 100°C case temperature and up to 400 volts forward and inverse ratings. *Operation at 125°C is now permissible with derating.* Full ratings are possible at 35°C ambient with a 5″ square heat sink. The peak control power is typically 1/200,000 of the output power!

Transitron's Silicon Controlled Rectifier has been designed into a new package for more rugged, convenient, and practical application. The 11/16″ hex base and the general outline coincide with EIA standards for the 20-ampere rectifier.

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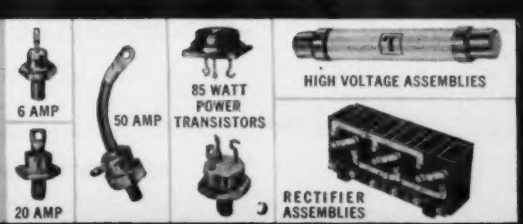

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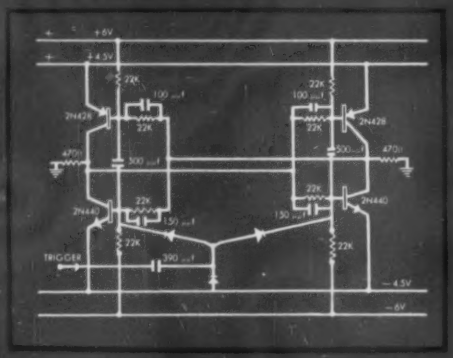

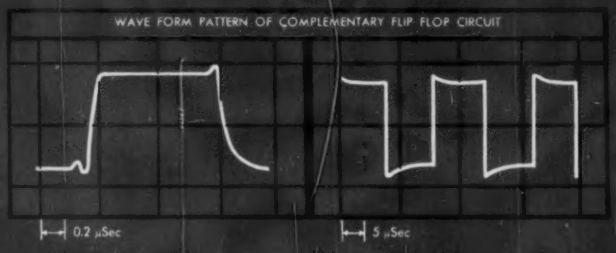

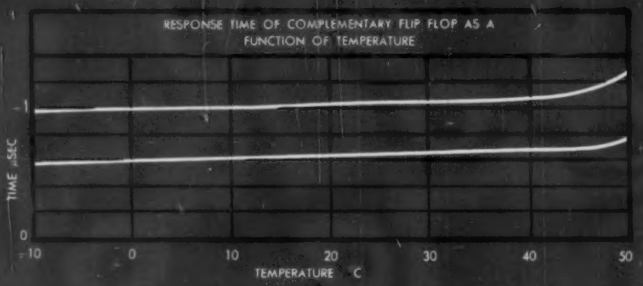

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- lower output impedance
- shorter rise and fall times

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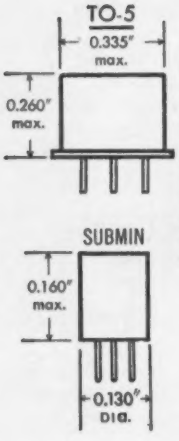

GERMANIUM PNP ALLOY — TO-5 CASE

Type	V_{CE} Volts	$f_{\alpha b}$ Avg. Mc	H_{FE1} I_B = 1MA V_{CE} = 0.25V	H_{FE2} Min. I_B = 10MA V_{CE} = 0.25V	Rise* Time Max.
2N404	−24	12	—	—	—
2N425	−20	4	20–40	10	1.0
2N426	−18	6	30–60	10	0.55
2N427	−15	11	40–80	15	0.44
2N428	−12	17	60	20	0.33
2N1017	−10	22	80	20	0.27

*I_C = 50MA; I_{B1} = 5MA; R_L = 200Ω I_{B2} = 5MA

GERMANIUM NPN ALLOY — TO-5 CASE

Type	V_{CE} Volts	$f_{\alpha b}$ Avg. Mc	H_{FE} Min. I_C = 50MA V_{CE} = 1.0V	Rise* Time Avg. μsec
2N438	25	6	20	0.7
2N439	20	11	30	0.5
2N440	15	17	40	0.3

*I_{B1} = I_{B2} = 1MA; I_C = 10MA; R_L = 1KΩ

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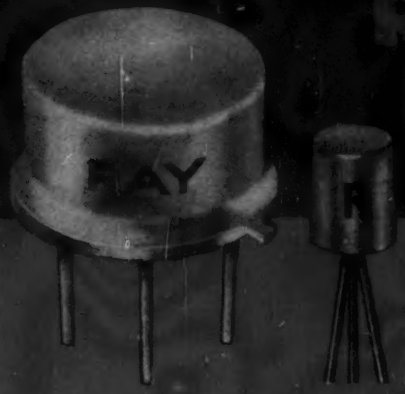
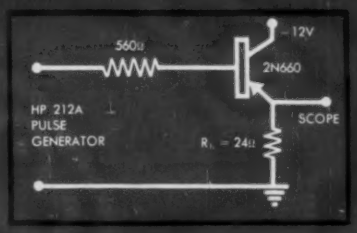
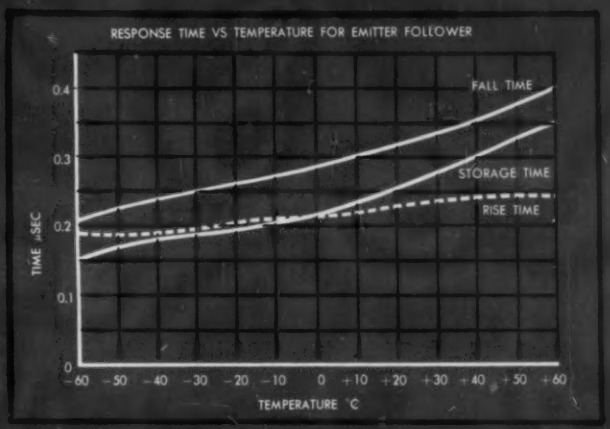


EMITTER FOLLOWER CIRCUIT





TESTED FOR COMPUTERS • DEPENDABLE IN COMPUTERS

High Current Switches

GERMANIUM PNP ALLOY — TO-5 CASE

Type	V_{CE} Volts	f_{ab} Avg. Mc	H_{FE1} I_B = 1MA V_{CE} = 0.25V	H_{FE2} Min. I_B = 10MA V_{CE} = 0.35V
2N658	−24	5	25–80	15
2N659	−20	10	40–110	25
2N660	−16	15	60–150	40
2N661	−12	20	80	55
2N662	−16	8	30	18

Subminiature Switches

GERMANIUM PNP ALLOY — SUBMIN CASE

Type	V_{CE} Volts Volts	f_{ab} Avg. Mc	H_{FE1} I_B = 1MA V_{CE} = 0.25V	H_{FE2} Min. I_B = 10MA V_{CE} = 0.35V	Rise* Time Max.
CK25	−20	4	20–40	10	1.0
CK26	−18	6	30–60	10	0.55
CK27	−15	11	40–80	15	0.44
CK28	−12	17	60	20	0.33

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MILITARY ELECTRONICS DIVISION — CHICAGO 24, ILLINOIS

URGENT PROBLEMS RELIABLY SOLVED

ELECTRONICS NEWSLETTER

TRAVELING-WAVE TUBE design trend is towards electrostatic focusing. That's one conclusion observers draw from sessions of the Electron Devices Meeting in Washington. Three papers were concerned with the technique of electrostatic focusing in the L, X and S-bands. Reason: the technique eliminates use of the heavy magnet which is sensitive to temperature and vibration. Interest was great in sessions devoted to low-noise devices, Esaki tunnel diodes and multi-functional solid-state devices.

Plasma-operated traveling-wave tube, recently reported seen in USSR by a touring Western Union engineer, has been under development for three years by at least one U. S. company. Fast electron beam is fired into a magnetically modulated plasma that functions as the slow-wave structure. Tube can handle large amounts of power without damage to parts due to beam spreading but is said to have a restricted bandwidth.

INTEGRATED BUILDING SECURITY SYSTEM guarding against intrusion, theft, vandalism and fire is being offered on a "building block" basis by Minneapolis-Honeywell Regulator Co. Heart of the system is a control console with push-buttons, two-way communications connecting to gates and indoor areas, alarm lights and bells and a 14-in television screen. Subsystem panels permit the guard-controller to identify the nature and location of troubles. Subsystems include fire and smoke detection devices; conventional intrusion detection; electronic noise detectors that permit the guard at the console to eavesdrop on particular areas; new motion detectors using light and sound patterns; electronic fencing using a new capacitance circuit and a built-in compensator to prevent false alarms; and automatic door and gate control using closed-circuit tv.

ELECTRONICS REPS will hold their first national convention Feb. 11-13, 1960, in Chicago. The Electronic Representatives Association expects the convention to become an annual event, says the first one will be a "strictly-business session" to aid ERA members improve their business management and sales effectiveness.

ELECTRONICS CONTRACTORS have been handed a new set of ground rules for determining allowable costs for defense work. Primarily, the new rules, effective July 1, 1960, put down in more detail what has been practice over the years. Although aimed primarily at cost-reimbursement type contracts, the new rules will guide Pentagon contract administrators on both negotiated and fixed-price contracts. The rules take 46 major cost items and spell out if and how the government will allow costs to be tallied. In some instances, the new policy represents a tightening up of controls. Interest, for example, won't be an allowable item under any type of contract, although it is allowed new in some contracts. In the case of research and development, the government is going to be more liberal in cost sharing. Copies of "Revision No. 50 Armed Services Procurement Regulation" are available from the Government Printing Office, Washington 25, D. C., for 35 cents.

NO-GIMBAL INERTIAL NAVIGATION SYSTEM designated the AJN-7 is being built and tested for the Air Force by Ford Instrument division of Sperry Rand under a $1-million contract. Accelerometers and gyros are strapped down, with the gyros exercising no control over the accelerometers. The latter follow any movement of the vehicle; the gyros measure deviations of the vehicle from its initial orientation. Signals from gyros and accelerometers go to a digital computer which provides speed, direction and location information.

PRODUCTION LINE REPORTING SYSTEM, a first approximation to industrial control, is being field-tested at Boeing's Wichita, Kans., plant. The IBM 357 data-collection system sets up a network of reporting stations, requires further computing, does not control so much as monitor. It comprises: stations about the size of time clocks; a control unit to sequence the transmissions from various stations; and a central station, which can handle up to 20 input stations, where incoming data is reproduced for machine processing. Clock can be added to record time. Rental for the system is about $100 a month per input station.

USSR has ordered a medium-speed transistorized computer, the National-Elliott 802, from Elliott Brothers of London. It's believed the Soviets will use it in power plant process control.

CARBON DIOXIDE SENSING DEVICE to guard the air supply of Project Mercury astronauts is being developed by Beckman Instruments for manned capsule prime contractor McDonnell Aircraft. Four-ounce device will monitor the level of carbon dioxide inside the astronaut's space suit. Measurements will be displayed to permit the astronaut to control the composition of his air supply. Readings will also be telemetered to earthbound scientists at remote controls.

CONTROL AND INSTRUMENTATION OF REACTORS course will be given Feb. 1 to 12, 1960, by the Harwell Reactor School under the auspices of the United Kingdom Atomic Energy Authority. It is open to overseas students who have a direct interest in the control and instrumentation of nuclear reactors. Applications and details may be obtained from The Principal, Reactor School, A.E.R.E., Harwell, Didcot, Berks, England.

4/4E

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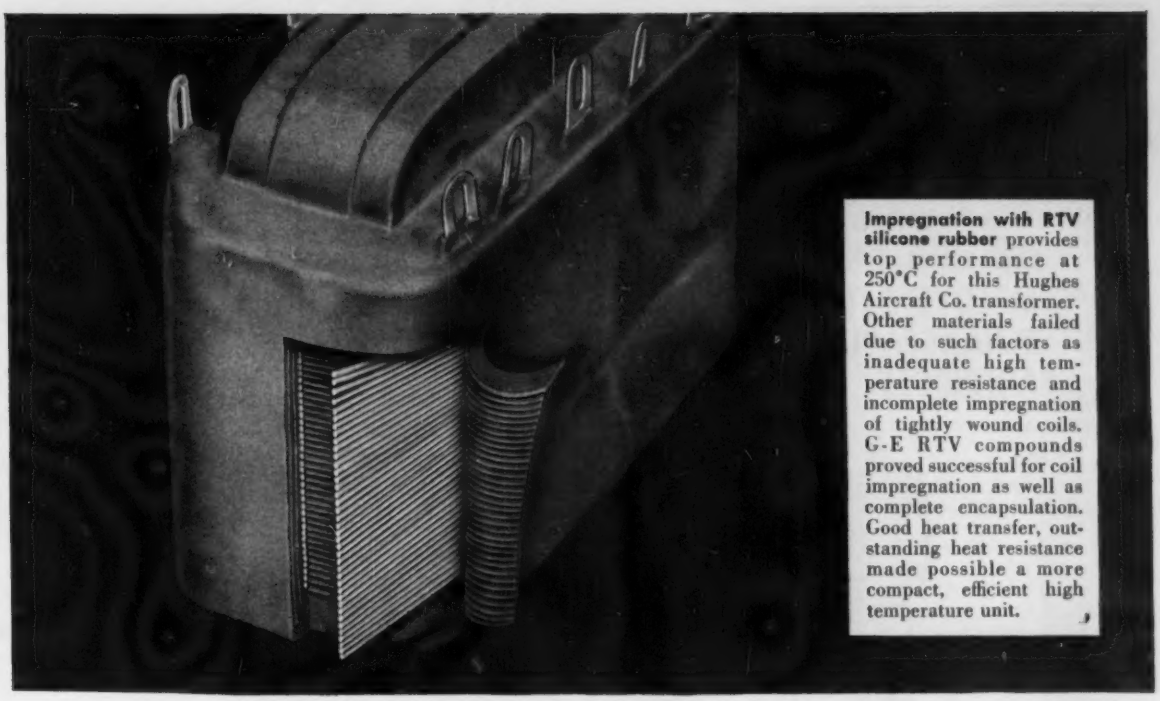
economy priced to save you money——continuous-duty design for long trouble-free service——interlocked keyboard——direct-action function keys—direct subtract—repeat add and subtract—7/8 cap. "addo-x" stands for a family of versatile adding-calculating machines——backed by nation-wide service and repair parts facilities see your dealer or write: "addo-x" 300 Park Avenue, New York 22



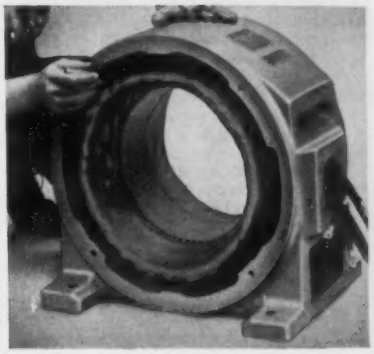
Impregnation with RTV silicone rubber provides top performance at 250°C for this Hughes Aircraft Co. transformer. Other materials failed due to such factors as inadequate high temperature resistance and incomplete impregnation of tightly wound coils. G-E RTV compounds proved successful for coil impregnation as well as complete encapsulation. Good heat transfer, outstanding heat resistance made possible a more compact, efficient high temperature unit.

Added protection, easier application with General Electric RTV silicone rubber insulation

Outstanding heat resistance and electrical properties combined with room temperature cure

New resilient, shock-absorbent RTV sponge offers improved shock and vibration protection at elevated temperatures; permits easier fabrication than previous methods of cutting, inserting and sealing sponge in place. With RTV, just add sponging and curing agents to compound and mix.

Protection from high altitude arc-over and corona is provided for this cathode ray tube by encapsulating all lead wires with RTV (room temperature vulcanizing) silicone rubber. Designed for airborne operation and installed in a non-pressurized section of the aircraft, tube is protected from arc-over and corona at altitudes up to 70,000 feet.



Extended service life for motors through RTV encapsulation of stator windings, introduced by General Electric motor departments. RTV's resistance to moisture and other contaminants enables these dripproof motors to meet certain applications formerly requiring totally enclosed units. RTV has low viscosity, rapid cure.

For application data and samples of General Electric RTV silicone rubber, write General Electric Company, Silicone Products Department, Section N118, Waterford, New York

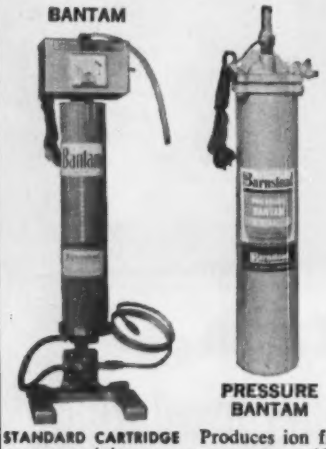
GENERAL ELECTRIC

Silicone Products Department, Waterford, New York

BARNSTEAD
BANTAM
DEMINERALIZER

DOES 5 WATER PURIFICATION JOBS
EMPLOYS 5 INTERCHANGEABLE CARTRIDGES

BANTAM



PRESSURE BANTAM

STANDARD CARTRIDGE Produces ion free water at minimum cost . . . removes 1500 grains as NaCl (1300 as $CaCO_3$).

MIXED RESIN CARTRIDGE For operations demanding better than 1,000,000 ohms resistance and neutral pH. Cartridge capacity is 1230 grains as NaCl (1050 at $CaCO_3$). Approximately ⅓ of cartridge capacity is million ohm water or better.

ORGANIC REMOVAL CARTRIDGE Removes organics, organic liquids and gases that would pass through a demineralizer. Effective in removing chlorine. Ideal for pre-treating demineralizer feedwater, for self-purifying high purity rinse systems and other processes where organics or odors in the water are objectionable.

OXYGEN REMOVAL CARTRIDGE Developed for cooling water loops where it is important to maintain low oxygen content to prevent corrosion. Cartridge removes one part per million of dissolved oxygen from 2500 gallons of water, or 6.8 liters (9.7 grains) of oxygen at standard temperature and pressure.

CATION CARTRIDGE Provides (1) precious metals recovery, (2) radio-active isotope recovery, at low cost, (3) also useful for removing volatile amines where heating plant steam condensate is being used as the feedwater for a Still, and (4) where close control over the pH of water is necessary, the cation cartridge in its ammonia or lithium form is effective.

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WASHINGTON OUTLOOK

WASHINGTON—NAVY SPENDING FOR POLARIS submarine-missile program will jump to around $1.6 billion next year with a great chunk of it going for electronic equipment.

That is the amount the Navy is asking for in its 1961 budget, and reports are the Pentagon will okay the measure. This is a sharp increase over the $600 million being spent this year.

The increase in Polaris spending comes from having 12 missile-launching submarines in various stages of construction. They are reaching the stage where the expensive outfitting is occurring. Navy expects to have the first three submarines at sea by the end of 1960. Between now and then, the bulk of the Polaris weapons system will be added to the vessels. Since 1957 some $2.6 billion has been spent on the program.

Six other Polaris submarines are under construction now and long-lead-time items are being purchased for another three.

Right now, Navy doesn't know when it will start construction on additional Polaris subs. No new starts are to be included in the 1961 budget that goes to Congress in January. Long range, the Navy wants to have 35 to 40 of the subs at sea, but some reports have it that no new starts will be made until the first submarines have actually proven out in sea operations.

Part of the $1.6 billion will go for building a powerful radio transmitter at Cutler, Maine. The transmitter will be used to communicate with the Polaris submarines once they start roaming the oceans. It is slated to be completed by 1962.

- **Facsimile mail transmission program has been underway for months,** but up to now, kept under tight wraps by the Post Office. Word of the project leaked out recently at the annual convention of the National Association of Postmasters in Washington.

  Postmaster General Arthur E. Summerfield and President Eisenhower both confirmed the project, but refused to discuss details. Reportedly, strong opposition to the move has been thrown up by Western Union and truck, rail and airlines that haul the mail.

Congress gave the Post Office Department $400,000 this year specifically to develop a mail facsimile system. International Telephone & Telegraph currently has a $140,000 development contract for the project. A test system has been installed between Washington and Los Angeles, and experimental transmission of mail has been going on for some time.

Long range, the Post Office envisions a facsimile network that would connect 178 major U.S. cities and serve 2/3 of the country's population. Existing American Telephone & Telegraph and perhaps some Western Union lines would be used for transmission.

The Post Office claims that the privacy of the mail would be retained. It plans to have mail transmitted, either typed or handwritten letters, through sealed envelopes. On the receiving end it would be processed, enveloped and addressed mechanically.

Cost of the service, Post Office says, would be no more than the 7 cents per oz. airmail rate; a 30-cent special delivery fee could mean cross-country delivery within an hour or so after mailing a letter. Post Office will check out technical feasibility first, then worry about problems like maintaining secure and private transmissions.

FROM LAGRANGIAN TO LIFT-OFF

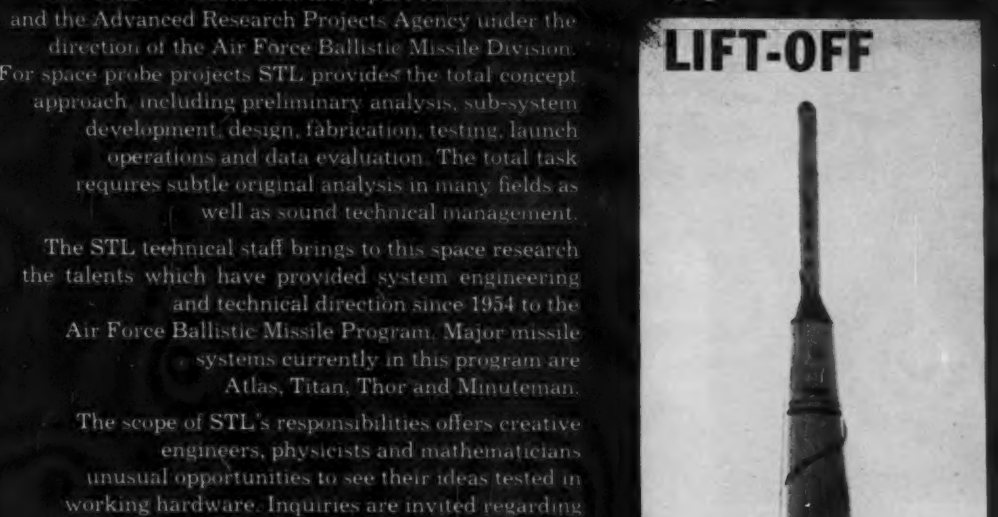
Sometimes forgotten during the thundering ascent of a space probe rocket are months of meticulous analysis, engineering and planning. The staff of Space Technology Laboratories is now engaged in a broad program of space research for the Air Force, the National Aeronautics and Space Administration and the Advanced Research Projects Agency under the direction of the Air Force Ballistic Missile Division. For space probe projects STL provides the total concept approach, including preliminary analysis, sub-system development, design, fabrication, testing, launch operations and data evaluation. The total task requires subtle original analysis in many fields as well as sound technical management.

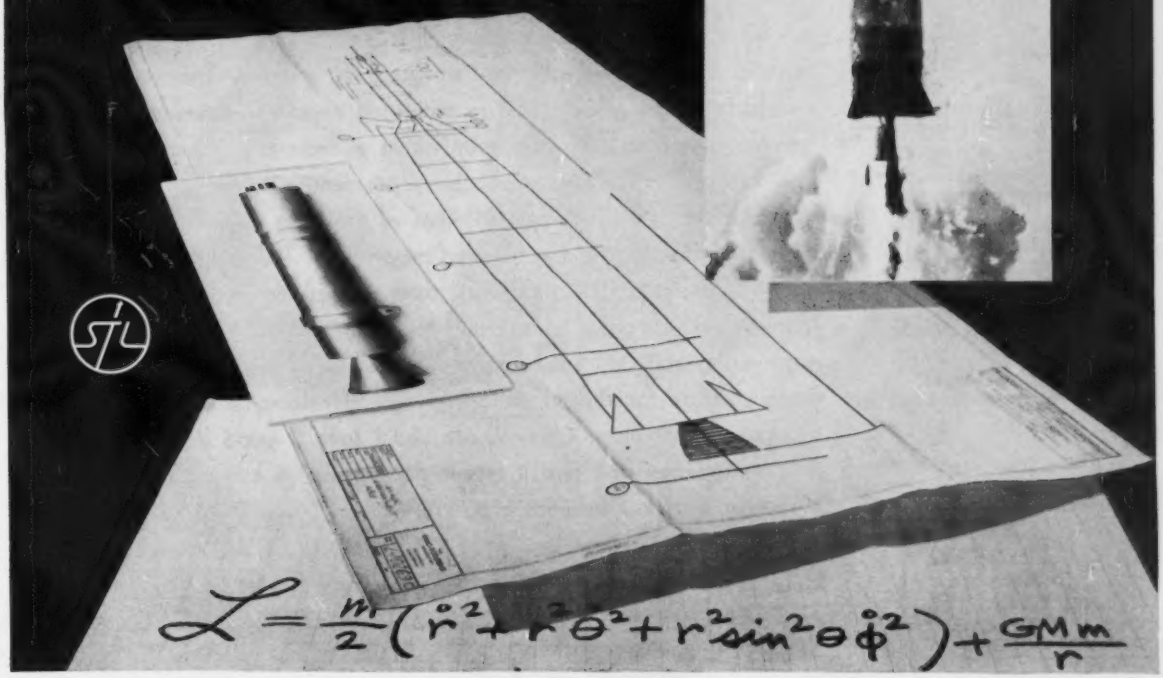
The STL technical staff brings to this space research the talents which have provided system engineering and technical direction since 1954 to the Air Force Ballistic Missile Program. Major missile systems currently in this program are Atlas, Titan, Thor and Minuteman.

The scope of STL's responsibilities offers creative engineers, physicists and mathematicians unusual opportunities to see their ideas tested in working hardware. Inquiries are invited regarding staff openings in the areas of Advanced Systems Analysis, Rocket Propulsion, Space Flight Mechanics, Dynamics, Structural Analysis, and Aerodynamics.

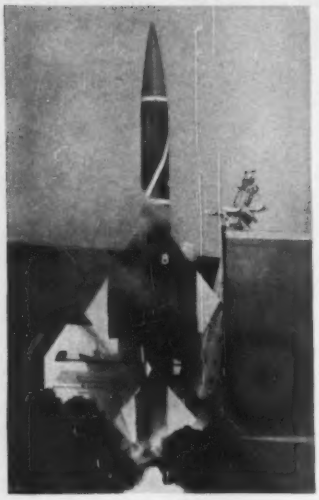
Space Technology Laboratories, Inc.

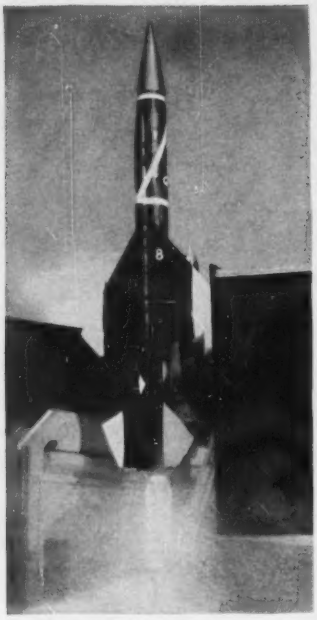
P. O. Box 95004, Los Angeles 45, California

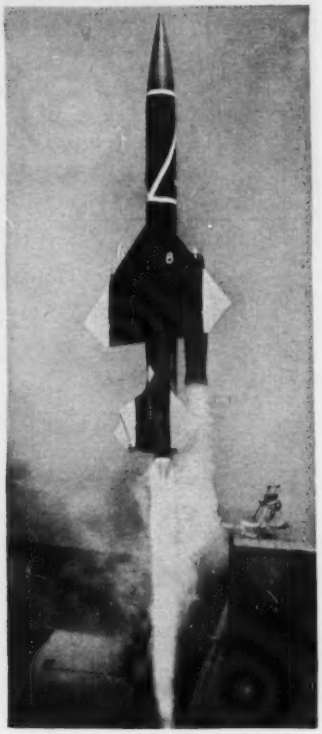




BORG ...a world of ideas ... *that work*







BOEING NEEDED SPECIALTY ENGINEERING...

AND GOT IT...FROM BORG

A FEW BORG DEVELOPMENTS

- FREQUENCY STANDARDS
- AIRCRAFT INSTRUMENTS
- PRECISION POTENTIOMETERS
- MULTI-TURN COUNTING DIALS
- FRACTIONAL H. P. MOTORS

Boeing Airplane Co. needed special potentiometers for the guidance systems of their deadly Bomarc surface-to-air missiles. The necessary potentiometers had to withstand severe vibration and shock and still retain uncanny accuracy within extreme tolerances. The solution to this difficult reliability problem? The design, development and production facilities of the Borg Equipment Division of the Amphenol-Borg Electronics Corporation. The result? Specially designed potentiometers exceeding all required specifications. Many industry leaders have found that they can depend on Borg engineering skill and cooperation. Call on Borg when you are faced with difficult design, development or production problems. Chances are you'll save a good deal of time and money and find it makes good sense to call on Borg. Write for our new facilities brochure.

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now there are 3

Honeywell, developers of the
original VISICORDER Ultra Violet
recording oscillograph principle,
now brings you a third
great Visicorder oscillograph . . . the

MODEL 1108 24-CHANNEL DIRECT-RECORDING VISICORDER OSCILLOGRAPH

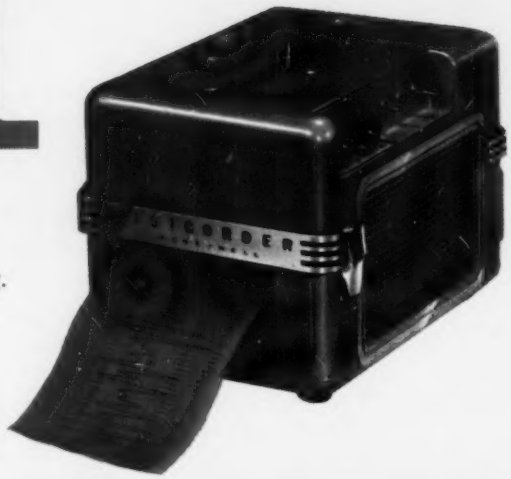
H
HONEYWELL

1

MODEL 906 VISICORDER

The original 8-channel Model 906 Visicorder was the first oscillograph to make use of the now-famous Ultra-Violet Visicorder recording principle, pioneered and developed by Honeywell. The 906 Visicorder was the first oscillograph to combine the high frequency response and writing speed of photographic-type oscillographs with the convenience of direct recording. Recent models incorporate time lines and grid lines, and record up to 14 simultaneous channels of data at frequencies from DC to 5000 cycles per second.

The 906 Visicorder is ideal for uses requiring up to 14 channels of data.



3

THE NEW MODEL 1108 VISICORDER OSCILLOGRAPH

Fitting ideally between the 14-channel 906 and the 36-channel 1012, the new 24-channel Model 1108 gives you direct writing Visicorder oscillography at the *lowest cost per channel.*

Like all Visicorders, the Model 1108 was designed from the base up to make the fullest use of the completely proven and unsurpassed Visicorder principle. The new 1108 also directly records at frequencies from DC to 5000 cycles per second at sensitivities comparable to photographic oscillographs. Like the Model 1012, the 1108 incorporates many automatic features and the years-ahead convenience of pushbutton controls.

The Model 1108 Visicorder, the most modern intermediate-size recording oscillograph on the market today, is ideal for intermediate uses requiring up to 24 channels of data.

2

MODEL 1012 VISICORDER

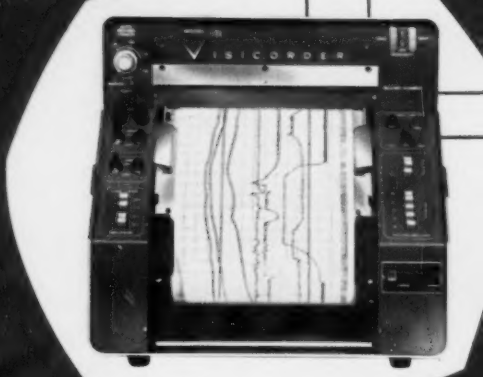
The Model 1012 Visicorder is the most versatile and convenient oscillograph ever devised for converting as many as 36 simultaneous channels of dynamic data into immediately-readable records. Like other Visicorders, the 1012 permits monitoring the information at the recording point as it goes on the record. It also records at frequencies from DC to 5000 cps.

The Model 1012 Visicorder, with its conveniences and broad capacities, is ideal for large-scale uses where up to 36 channels of data are required.

NEW MODEL 1108 VISICORDER provides the ultimate i

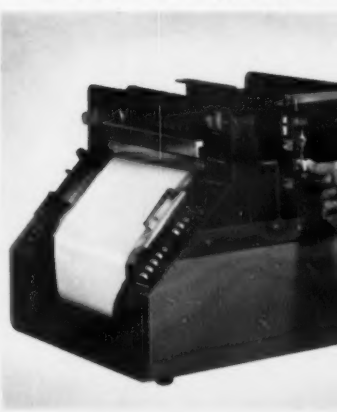
unlimited variety of applications.

The Model 1108 may be used in direct connection with many types of transducers where high frequency recordings are not required. Or it may be teamed with various types of amplifiers where high-frequency—high amplitude readout is desirable. A broad selection of galvanometers with a wide variety of sensitivities and frequencies is available. A schematic diagram designed to suggest sample hookups for various applications—with and without amplification—appears at lower right, and demonstrates the wide variety of uses to which this one recording system may be put.

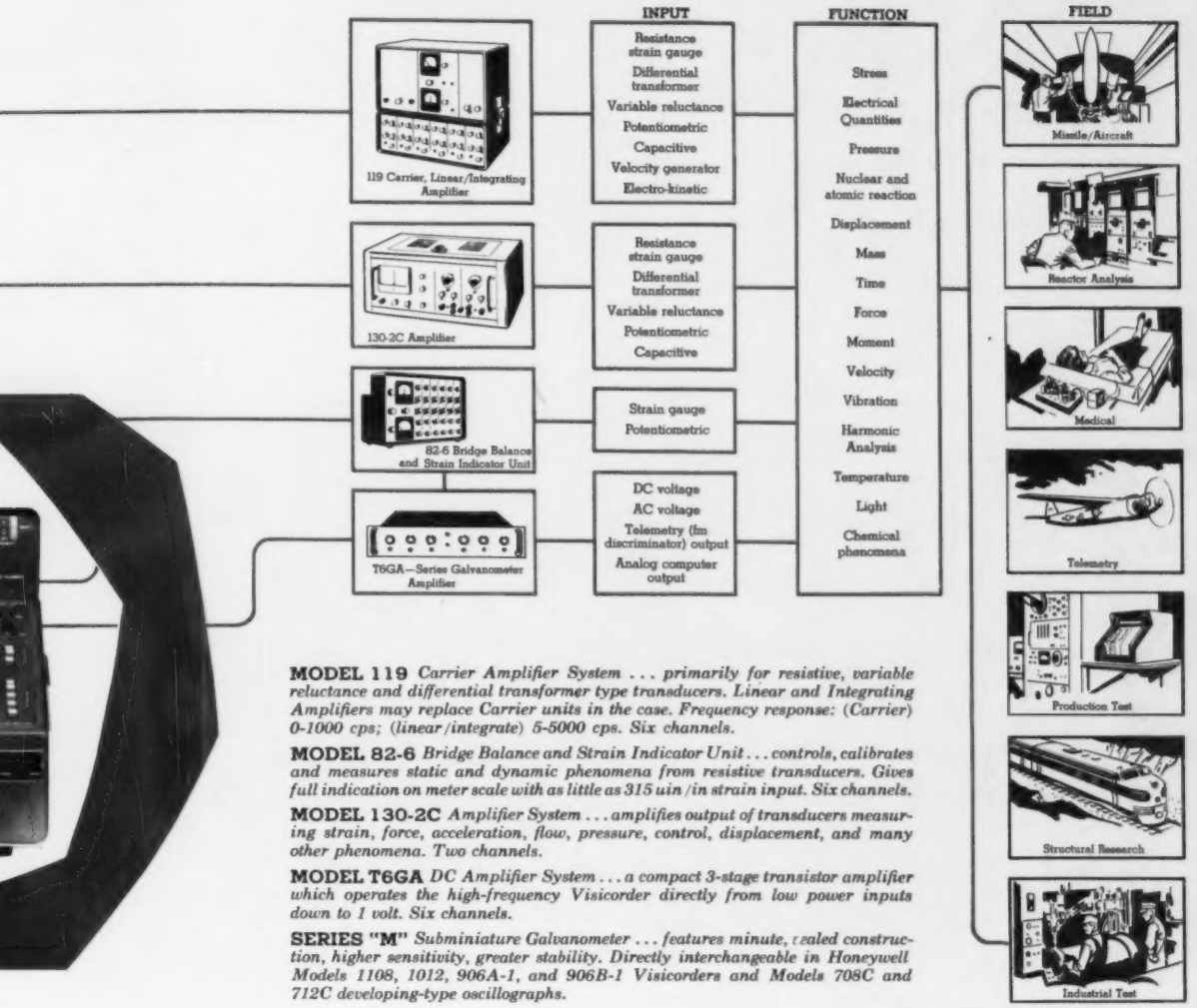


EASY PAPER LOADING . . . *Paper supply assembly swings forward, supply roll drops easily into place. No threading required.*

CONVENIENT ACCESS . . . *Covering cleaning of optical components, calibrating REAR VIEW shows rear-panel input co*



nate in immediate, convenient readout of data in an



MODEL 119 *Carrier Amplifier System . . . primarily for resistive, variable reluctance and differential transformer type transducers. Linear and Integrating Amplifiers may replace Carrier units in the case. Frequency response: (Carrier) 0-1000 cps; (linear/integrate) 5-5000 cps. Six channels.*

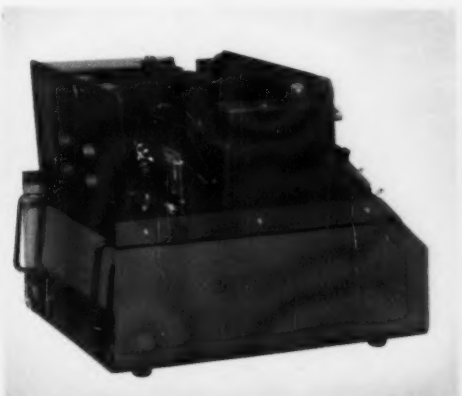
MODEL 82-6 *Bridge Balance and Strain Indicator Unit . . . controls, calibrates and measures static and dynamic phenomena from resistive transducers. Gives full indication on meter scale with as little as 315 uin/in strain input. Six channels.*

MODEL 130-2C *Amplifier System . . . amplifies output of transducers measuring strain, force, acceleration, flow, pressure, control, displacement, and many other phenomena. Two channels.*

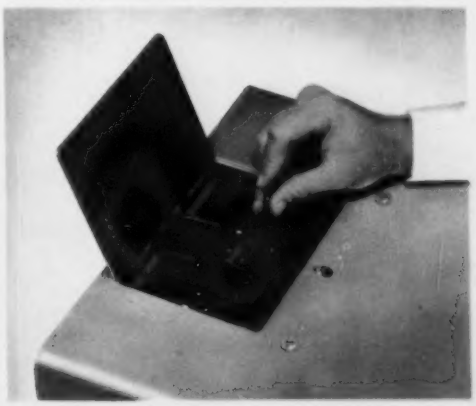
MODEL T6GA *DC Amplifier System . . . a compact 3-stage transistor amplifier which operates the high-frequency Visicorder directly from low power inputs down to 1 volt. Six channels.*

SERIES "M" *Subminiature Galvanometer . . . features minute, sealed construction, higher sensitivity, greater stability. Directly interchangeable in Honeywell Models 1108, 1012, 906A-1, and 906B-1 Visicorders and Models 708C and 712C developing-type oscillographs.*

. . Covering panels on instrument are readily removable for easy access to lamp, calibrating timer, and to service other assemblies. (THREE-QUARTER el input connectors.)



EASY GALVANOMETER ADJUSTMENT . . . *provided through top panel. No clamping or locking is required. Galvanometer spots may be observed at recording point while adjustment is being made.*

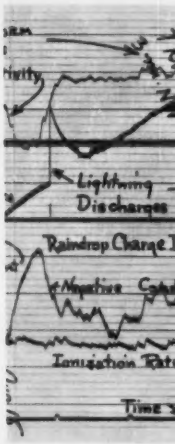


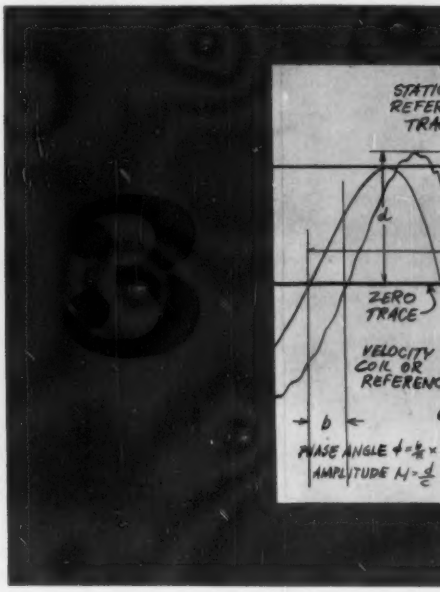
TYPICA

MODEL 1108 VISICORDER

adds still more versatility to the Honeywell family of direct recording oscillographs.

Designed to the utmost standards of customer convenience, high-frequency and high sensitivity recording, and reliable, accurate performance, the Model 1108 continues the long-standing tradition of Honeywell leadership through creative engineering. Examine the diagram below for feature-by-feature evidence of this leadership.





FEATURES OF THE 1108

General Features

1. **AUTOMATIC RECORD LENGTH CONTROL** . . . *adjustable from 1 to 25 feet . . . indicator shows amount of pre-set record length remaining.*
2. **VISIBLE RECORDING POINT** . . . *galvanometer spots may be monitored through amber screen as they record.*
3. **GRID LINE INTENSITY CONTROL** . . . *manually adjustable to compensate for exposure at various record speeds. (Grid line spacing: 0.1 inch, 5th line accentuated. Custom grid spacings on special order.)*
4. **GALVANOMETER SPOT INTENSITY CONTROL** . . . *off, on, and manually adjustable to control sharpness of galvanometer traces at various record speeds and writing speeds.*
5. **RECORD NUMBERING** . . . *Four-digit resettable record-number counter photographed at start of each record. Flash-tube type; may also be used as event marker.*
6. **RECORD DRIVE CONTROL and INDICATOR** . . . *"Forward" for recording; "reverse" for closer study and analysis of data after recording has been made. Indicator signal light turns off if recording is not taking place.*
7. **RECORD SPEED INDICATOR.** *pushbuttons for 5 speeds plus 3 range pushbuttons give you 15 separate speeds. Speeds may be changed during operation. Positive clutches, no gear meshing.*
8. **TIME LINE SYSTEM** . . . *Electronic flash type, instant warmup. Three selectable intervals: 1, .1, and .01 seconds. No optical parallax. May also be operated from external signal and in multiplex.*
9. **RECORDING LAMP ON-OFF CONTROL AND INDICATOR**
10. **POWER ON-OFF CONTROL AND INDICATOR**
11. **RECORDING PAPER CAPACITY** . . . *8" x 200 feet of standard-weight paper; 350 feet of thin base paper. Take-up integral with record-drive system.*
12. **GALVANOMETERS** . . . *access through top panel. Accepts up to 24 Series M Subminiature galvos, plus 4 static reference galvos. Directly interchangeable among Honeywell Models 906A-1, 906B-1, 1012, 700C oscillographs.*
13. **PAPER KNIFE** . . . *manually operated.*

Other Features

TRACE IDENTIFICATION . . . *at 45° slope, 1/8" width, interrupting galvos in sequence on approximately 8" spacing.*

OPTICAL ARM . . . *11.8 inches (30cm) standard in all Honeywell oscillographs.*

LAMP AND CIRCUIT . . . *High-pressure mercury vapor lamp. Automatic starting.*

REMOTE OPERATION . . . *Control circuits provided for remote operation.*

INPUT POWER . . . *105-130 volts; 60 cycle; 7 amps. 50 and 400 cycle models also available.*

MOUNTING . . . *Table and rack. Shock or vibration mounting using available accessories.*

OTHER

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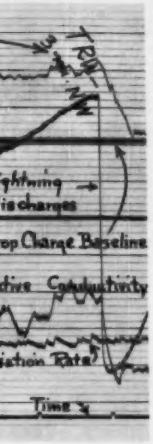
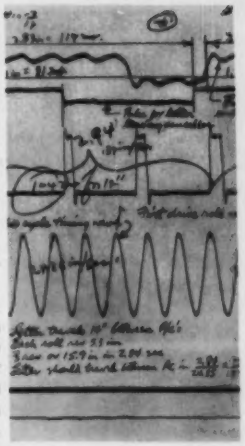
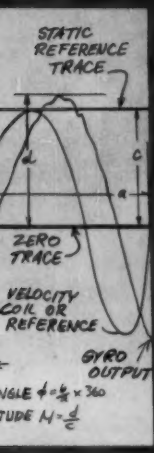
ICAL USES OF THE VISICORDER



In weather research...
This Visicorder record gave U.S. Weather Bureau scientists immediate readout of thunderstorm data taken at Mt. Washburn in Yellowstone National Park. As the storm system passed, the Visicorder recorded positive and negative air conductivity, rate of ionization of air, raindrop charge, corona discharge current from an insulated tree and a 4' x 6' grass plot, times of camera exposure photographing droplet size and electrical charge, atmospheric potential gradient, and time.

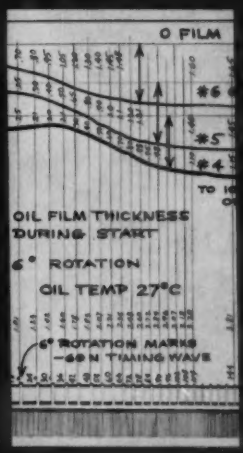
In development test...
This directly-recorded Visicorder record shows a canceller test of letters through a new mail-handling machine developed by Emerson Research Laboratories for the U.S. Postoffice Department. The Visicorder test took only 3 hours to solve a 3-week problem: why letters, travelling at the rate of 30,000 letters per hour, changed speed as they went through the machine. (Constant speed is necessary to register cancellation on the stamp every time.) Motor speed variations, belt slippage, and letter slippage in the drive rollers were responsible. A synchronous-drive motor, a timing belt drive, and a better grade of rubber in the drive rollers were added to solve the problem at a vast saving in engineering time.





In production...

Industrial design...



HER USES of the Model 1108 Visicorder . . . as a direct readout unit IN RECORDING MONITORING SYSTEMS . . . IN MISSILE AND ENGINE ANALYSIS for test stand recording or analog recording OF TELEMETERED SIGNALS . . . IN CONTROL to monitor reference and signals . . . IN NUCLEAR TEST to record temperatures, pressures, impacts, etc. . . . IN LABTORIES for all purpose analysis . . . IN PRODUCTION for final dynamic inspection . . . IN COMING for immediately-readable analog records . . . IN PILOT COMPONENT TESTS for rapid ation of prototypes . . . IN ALL TESTS which are non-repetitive in sequence, making oscilloscopes actical.

Honeywell

Industrial Products Group

For further information including prices and delivery, write Minneapolis-Honeywell Regulator Company, Industrial Products Group, Heiland Division, 5200 E. Evans Ave., Denver 22, Colorado.

proven reliability for all applications

3 NEW MIL SPEC POWER TRANSISTORS FROM MOTOROLA

For highest reliability in the toughest environments, specify one of these new Motorola germanium PNP, alloy junction power transistors:

TYPE 2N1011 — 3AMP to 80 Volts (meets MIL-T-19500A/67 Sig C)
TYPE 2N1120 — 10AMP to 80 Volts (meets MIL-T-19500A/68 Sig C)
TYPE 2N297A — 3AMP to 60 Volts (meets MIL-T-19500A/36 Sig C)

Immediately available from Motorola's bonded warehouse, these high-voltage units are designed for use in military equipment where semiconductor devices must meet MIL-T-19500 specs—including audio amplifier, power supply and converter applications in aircraft and ground support equipment. Motorola's copper-strap internal construction provides the ruggedness they need for operation under environmental extremes at temperatures ranging from −65°C to +100°C. All are hermetically sealed in an industry standard TO-3 package with type 2N1120 having .052" pins with solder lugs attached.

Production Quantities available from Motorola stock for immediate delivery. For engineering quantities, contact your nearest Motorola Semiconductor distributor.

WHAT IS YOUR POWER NEED?

Motorola's complete range of industrial power transistors gives you power for every purpose. Three separately designed series offer current handling capacities of 3, 10 and 25 amps...and a wide range of voltage ratings to suit your individual requirements. All of the transistors listed in the adjoining table have welded hermetic seals and meet or exceed mechanical and environmental requirements of MIL-T-19500A.

POWER TRANSISTOR	Maximum Ratings			Typical Electrical Characteristics	
	Type Number	BV_{CBO} volts	BV_{CES} volts	h_{FE} @ I_C amps	
25 AMP TO 100 VOLTS	2N1167*	100	75	25	25
	2N1166	100	75	25	25
	2N1165*	80	60	25	25
	2N1164	80	60	25	25
	2N1163*	50	35	25	25
	2N1162	50	35	25	25
	$T_J = 100°C$				
10 AMP TO 100 VOLTS	2N630*	100	75	18	10
	2N629*	80	60	18	10
	2N628*	60	45	18	10
	2N627*	40	30	18	10
	2N1120*	80	70	20	10
	$T_J = 100°C$				
3 AMP TO 80 VOLTS	2N375	80	60	22	3
	2N618	80	60	35	3
	2N297A	60	50	35	2
	2N1011	80	80	45	3
	$T_J = 100°C$				

*Supplied in TO-3 package with solder terminals.

FOR COMPLETE TECHNICAL INFORMATION regarding Motorola power transistors contact your nearest Motorola Semiconductor regional office:

RIDGEFIELD, NEW JERSEY
540 Bergen Boulevard
WHitney 5-7500
from New York WI 7-2980

CHICAGO 39, ILLINOIS
5234 West Diversey Avenue
AVenue 2-4300

HOLLYWOOD 28, CALIFORNIA
1741 Ivar Avenue
HOllywood 2-0821

OUTSIDE U.S.A. AND CANADA WRITE: MOTOROLA INTERNATIONAL, S.A.
4545 West Augusta Boulevard
Chicago, Illinois

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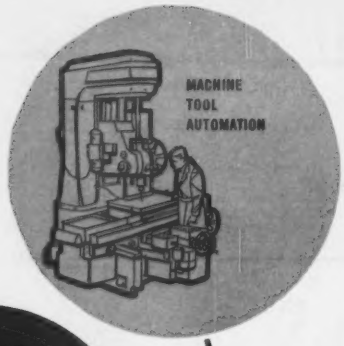
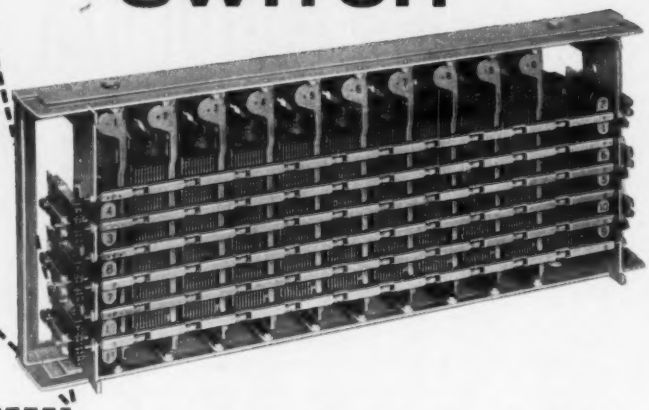
MOTOROLA SEMICONDUCTORS

MOTOROLA, INC.,
5005 E. McDOWELL, PHOENIX, ARIZONA



versatile is the word for NORTH CROSSBAR SWITCH



North Electric's Crossbar Switch, a 10x10x12 matrix configuration providing 1200 switching points, delivers an almost limitless range of switching capabilities and provides new efficiencies and economies in industrial applications with absolute reliability!

North's Crossbar Switch versatility has been proven by its application to a wide variety of operational demands.

This proven versatility will open new potentials for you in the solution of complex switching problems.

For further information write

INDUSTRIAL DIVISION

NORTH ELECTRIC COMPANY

4912 S. MARKET ST., GALION, OHIO

1884 1959 75TH AND GREATEST YEAR

New Names on Main Boards

TRADING in common stock of **Lear, Inc.** will now be done on the New York Stock Exchange. The stock was formerly traded on the American Exchange. Traded under the symbol "LEA", the stock made its NYSE debut at 18¼.

• Stock of **Microwave Associates, Inc.**, Burlington, Mass., has also switched by moving from over-the-counter status to the American Stock Exchange. The firm, involved in manufacture of microwave radar gear including power and switching tubes, is now actively producing a line of semiconductor products for high-speed computer application.

• **Nine-month gains** of 37 percent in value of shipments and 39 percent in net earnings, compared with figures for the corresponding period in 1958, are reported by **Assembly Products, Inc.**, Chesterland, O., manufacturer of instruments and controls. Shipments for the first nine months of this year totaled $2,052,528, while earnings topped the $130,000 mark. The company's new developments in continuous reading meter-relays, along with work in miniaturized controls, are seen as major factors for continued advancements, say company officials.

• Profit and backlog levels of **Electronic Sepecialty Co.**, Los Angeles, have reached record proportions, according to W. H. Burgess, ESC president. For the first six months of this year, sales amounted to $5,544,000, compared with sales of $1,970,000 in the same period a year ago. Earnings per share rose from 3 cents to 49 cents.

• **Hoffman Electronics Corp.**, Los Angeles, reports a 25-percent rise in net earnings for the first nine months of this year. The total is $1,565,366, equal to $1.04 a share on 1,506,322 shares outstanding. The 1958 figures are: earnings of $1,248,963, or 84 cents a share on 1,476,756 shares outstanding. Sales for this year from Jan. 1 to Sept. 30 totaled $35,261,157, up 24 percent from last year.

• Net earnings for **RCA** are up 38 percent at the end of this year's third quarter, sales are 17 percent higher. Net profits for the first nine months amounted to $27,300,000. Sales came to $978,000,000, compared with $834,800,000 for the same period in 1958. Earnings per share for the third quarter were 51 cents, an increase of 28 percent over 1958's third quarter. The nine-month earnings were $1.80 a share, a rise of 43 percent.

• **Radiation Inc.**, New York, announces a 38-percent sales rise and a 20.5-percent increase in earnings during the fiscal year ended Aug. 28. Sales reached $14,005,743, compared with $10,079,882 last year. Earnings were $588,992 as against $488,738 in the same period in 1958.

25 MOST ACTIVE STOCKS

WEEK ENDING OCTOBER 30

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Lear	4,671	23	18⅛	23
Elec & Mus Ind	1,791	9¼	7⅞	9
Sperry-Rand	1,550	24⅛	21⅜	24
Reeves Soderft	1,541	10¾	7½	10⅜
Avco Corp	1,333	14⅛	13⅝	13⅞
Dynamics Corp	1,168	11	8⅛	10¾
Varian Assoc	898	42⅜	37⅞	42
Int'l Tel & Tel	813	38¼	36⅝	37½
Ampex	775	111¾	100½	109
Gen Prec Equip	727	49¾	43¼	47
Raytheon	701	53½	50⅛	52¾
DuMont	660	9⅞	8⅛	8⅛
Burroughs	652	32⅞	29	32⅞
Cons Elec'dynmcs	650	42½	39	40⅞
Gen Dynamics	646	46	42⅞	43
Westinghouse	641	98	93	97⅞
Gen Electric	627	81⅞	77¼	80¾
Zenith	625	112¾	99¾	112¾
RCA	623	63⅝	59	63⅝
Gen Tel & Elec	484	72⅝	71⅜	71¾
Beckman	465	64¼	60	62
Clarostat Mfg	457	10⅜	8¼	9⅞
Emerson	430	17	14⅛	16¼
Univ Control	395	18	17⅛	17⅛
Philco	386	26⅜	24½	25⅞

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.

DIVIDEND ANNOUNCEMENTS

	Amount per Share	Date Payable
Burndy Corp.	$ .15	Nov. 17
Nat'l Aeronautical	.08	Oct. 29
Trav-Ler Radio	.05	Nov. 2
Energy Fund Inc.	.19	Oct. 8
Daystrom Inc.	.30	Nov. 16
Sanders Associates	.04	Oct. 12
Electric Autolite	1.10	Dec. 18

THE LEGENDARY FIREBIRD, the Phoenix, rose young and strong again and again from flames . . . This is the Norton Firebird . . . symbol of the exciting new fused materials made in Norton's electric furnaces.

Helpful Booklet on
OXIDES
and other
electro-chemicals

From the white hot caldrons of huge electric furnaces at Norton Company come OXIDES with capabilities hardly less miraculous than those of the Phoenix itself.

In furnace flames ZIRCONIUM OXIDE develops properties which make it useful as a metallurgical and chemical source material, a thermal insulator, and as a basic material for high temperature refractories and heating elements. Aluminum oxide evolves into high purity versatile ALUNDUM® FUSED ALUMINA; and MAGNORITE FUSED MAGNESIA attains its outstanding value as a high temperature electrical insulator.

These Norton furnaces also produce other oxides widely used in research and development and now finding production applications: fused diopside, mullite, dolomite, spinels . . . chromic oxide and lime. There are *hundreds* of applications for Norton OXIDES. Learn how they can improve *your* product quality and processing efficiency.

Write for booklet shown above. NORTON COMPANY, Electro-Chemical Division, 955 New Bond Street, Worcester 6, Massachusetts.

*Trade-Mark Reg. U.S. Pat. Off. and Foreign Countries

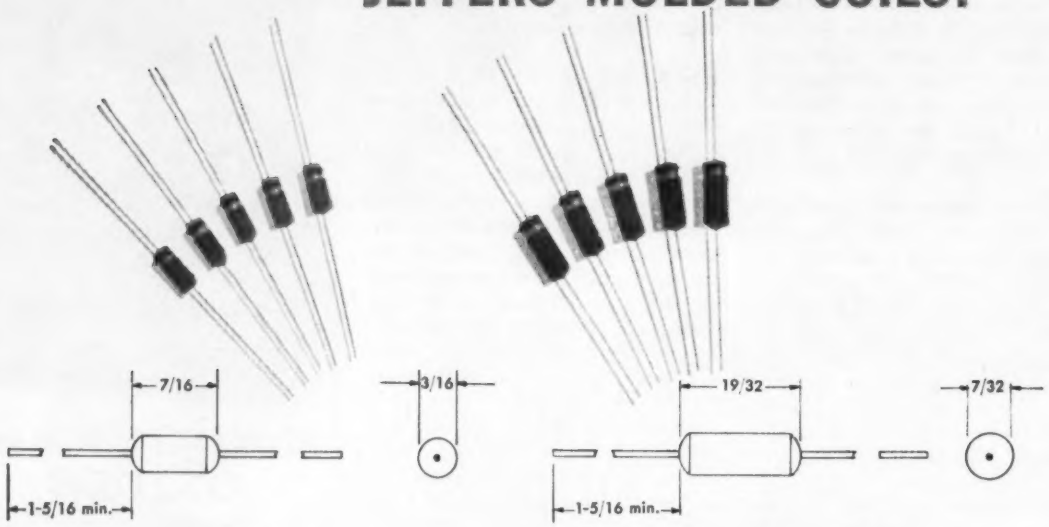
NORTON
ELECTRO-CHEMICALS

GIFTS OF THE FIREBIRD: compounds of silicon zirconium • boron • aluminum • magnesium titanium • chromium . . . including many borides carbides • nitrides • oxides

MAKING BETTER PRODUCTS
. . . TO MAKE
YOUR PRODUCTS BETTER

Proved in design... construction... and performance

JEFFERS MOLDED COILS!



TYPE NO. 101

PART NUMBER	L-Micro-henries	L-Tol. Plus or Minus	Approx. Fr Mc	Min. Q	at MC	R dc Max. 25°C	Max. I dc. MA
10100-20	0.15	20%	540	45	25	0.03	3650
" -22	0.22	"	450	45	25	0.04	3160
" -24	0.33	"	385	45	25	0.07	2400
" -26	0.47	"	335	45	25	0.08	2230
" -28	0.68	"	285	40	15	0.15	1630
" -30	1.00	"	230	30	10	0.30	1150
" -32	1.50	"	190	30	10	0.50	900
" -34	2.20	"	155	30	8.0	1.10	600
" -36	2.70	10%	140	30	7.0	1.20	570
10102-20	3.30	"	80	25	6.0	0.15	1630
" -22	3.90	"	75	25	6.0	0.16	1580
" -24	4.70	"	70	25	5.5	0.22	1350
" -26	5.60	"	62	30	5.0	0.30	1150
" -28	6.80	"	55	30	4.5	0.40	1000
" -30	8.20	"	53	30	4.5	0.45	940
" -32	10.0	"	47	30	4.0	0.60	810
" -34	12.0	"	42	45	3.5	1.00	620
" -36	15.0	"	38	45	3.0	1.20	575

TYPE NO. 102

PART NUMBER	L-Micro-henries	L-Tol. Plus or Minus	Approx. Fr Mc	Min. Q	at MC	R dc Max. 25°C	Max. I dc. MA
10200-20	0.47	20%	335	50	15	0.06	3160
" -22	0.68	"	280	50	14	0.10	2400
" -24	1.00	"	230	45	10	0.15	2000
" -26	1.50	"	190	45	10	0.28	1450
" -28	2.20	"	155	40	8.0	0.50	1100
" -30	2.7	10%	140	40	8.0	0.70	920
" -32	3.3	"	120	35	6.0	1.40	650
" -34	3.9	"	112	35	6.0	1.50	630
" -36	4.7	"	110	35	5.0	1.80	575
10203-20	5.6	"	60	35	5.0	0.15	2000
" -22	6.8	"	54	35	4.0	0.20	1730
" -24	8.2	"	50	35	4.0	0.25	1550
" -26	10.0	"	49	35	3.5	0.30	1400
" -28	12.0	"	40	40	3.0	0.50	1100
" -30	15.0	"	37	40	2.5	0.60	1000
" -32	18.0	"	34	50	2.5	0.80	860
" -34	22.0	"	29	60	2.5	1.20	700
" -36	27.0	"	27	65	2.0	1.40	650
" -38	33.0	"	24	70	2.0	1.90	560
" -40	39.0	"	23	70	2.0	2.00	550

Jeffers Coils are designed to give circuit engineers a standardized inductor line on which they can rely. The millions of Jeffers Coils made and sold every year are proof that they give just what's promised: longer, *more useful* service life!

Jeffers Molded Coils are engineered for dependability by virtue of their rugged mechanical construction and through the use of time-proven materials and manufacturing techniques. Only three physical sizes are required to cover a wide inductance range. Small size and close dimensional tolerances of the Jeffers Molded Coils make them ideal for automatic insertion.

JEFFERS MOLDED COILS

proved in extended life-performance tests!

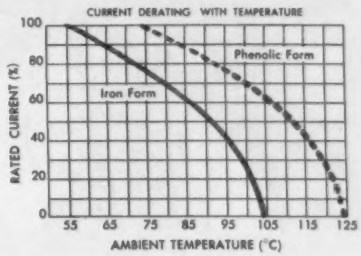
Jeffers Molded Coils are engineered to provide stabilized electrical characteristics for many thousands of hours of useful life under a variety of operating conditions.

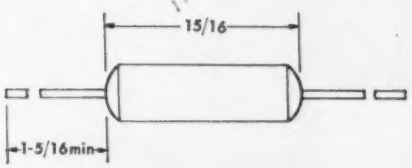
TYPICAL CHARACTERISTICS FOR TYPE 101 COILS.*

Moisture Resistance (MIL-STD-202, Method 106)

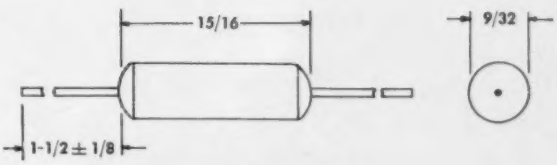
Change in: Inductance . . . . . Less than 2%
Change in: Resistance . . . . . Less than 2%
Change in: Resonant Frequency . . Less than 4%
Change in: Q Value . . . . . Less than 10%
Life Expectancy . . 20,000 hours plus at maximum operating temperature

*(Data for other types available on request.)





TYPE NO. 104



TYPE NO. 404

PART NUMBER	L-Micro-henries	L-Tol. Plus or Minus	Approx. Fr Mc	Min. Q	at MC	R dc Max. 25°C	Max. I dc. MA
10402-20	1.2	20%	200	60	10	0.09	2980
" -22	1.5	"	180	65	10	0.12	2580
" -24	2.2	"	145	65	10	0.20	2000
" -26	2.7	10%	130	55	8.0	0.28	1700
" -28	3.3	"	125	50	6.0	0.32	1580
" -30	3.9	"	110	45	5.0	0.50	1260
" -32	4.7	"	100	45	5.0	0.60	1150
" -34	5.6	"	90	45	5.0	0.95	920
" -36	6.8	"	85	40	4.0	1.10	850
" -38	8.2	"	80	40	4.0	1.20	810
" -40	10.0	"	70	40	3.5	1.80	670
" -42	12.0	"	60	40	3.0	2.70	545
" -44	15.0	"	57	40	3.0	3.00	510
" -46	18.0	"	53	35	2.5	4.80	410
0404-20	**22.0**	"	**27**	**40**	**2.5**	**0.30**	**1630**
" **-22**	**27.0**	"	**25**	**40**	**2.0**	**0.36**	**1500**
" **-24**	**33.0**	"	**22**	**45**	**2.0**	**0.60**	**1150**
" **-26**	**39.0**	"	**20**	**45**	**1.8**	**0.80**	**1000**
" **-28**	**47.0**	"	**18**	**70**	**1.5**	**1.20**	**820**
" **-30**	**56.0**	"	**17**	**70**	**1.5**	**1.30**	**780**
" **-40**	**68.0**	"	**15**	**75**	**1.5**	**1.90**	**650**
" **-32**	**82.0**	"	**14**	**85**	**1.2**	**2.20**	**600**
" **-34**	**100.0**	"	**13**	**85**	**1.0**	**2.80**	**530**
" **-36**	**120.0**	"	**11**	**85**	**1.0**	**4.00**	**450**

JEFFERS PART No.	Mil Type Designation	Inductance UH	Q Min.	Meas. Freq. MC	Self Res. Freq. MC	DC Res. Max. Ohms	DC Current Rated MA
40402-1	LT8K001	1.1 ±20%	60	10.0	200 ±10%	.09	2800
40402-2	LT8K002	2.2 ±20%	65	10.0	165 ±10%	.20	1800
40402-3	LT8K003	3.3 ±10%	50	6.0	130 ±10%	.32	1500
40402-4	LT8K004	4.7 ±10%	45	5.0	100 ±10%	.60	1100
40402-5	LT8K005	6.8 ±10%	40	4.0	90 ±10%	1.10	800
40402-6	LT8K006	10.0 ±10%	40	3.5	70 ±10%	1.80	600
40402-7	LT8K007	15.0 ±10%	40	3.0	55 ±10%	3.00	500
40402-8	LT8K008	22.0 ±10%	30	2.5	27 ±10%	.30	1500
40402-9	LT8K009	33.0 ±10%	45	2.0	21 ±10%	.60	1100
40402-10	LT8K010	47.0 ±10%	70	1.5	16 ±10%	1.20	700
40402-11	LT8K011	82.0 ±10%	85	1.2	14 ±10%	2.20	600
40402-12	LT8K012	100.0 ±10%	85	1.0	14 ±10%	2.80	500
40402-13	LT8K013	120.0 ±10%	85	1.0	13 ±10%	4.00	400

AND DON'T FORGET JEFFERS TECHNICAL SERVICE! You're invited to submit your inductor design problems for evaluation and solution at no cost or obligation. You can be sure you're getting the *right* answer from Jeffers.

Light face type denotes coils on phenolic coil forms.
Bold face type denotes coils on powdered iron forms.

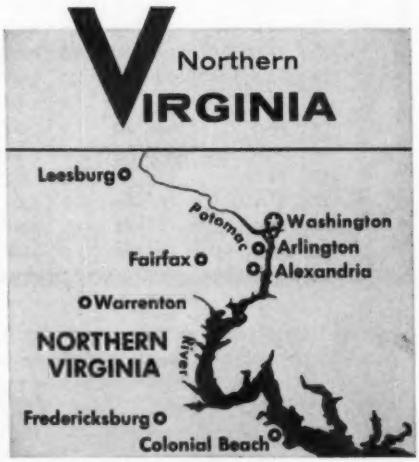
*Per MIL-C-15305A, MS 91189 (15 December 1953)

JEFFERS ELECTRONICS DIVISION
Speer Carbon Company,
Du Bois, Pennsylvania

You can see Washington Monument from our new lab...

There couldn't be a righter spot than Northern Virginia for your new research center, pharmaceutical plant or other light industry. It's close to the facilities of the Nation's Capital. And skill runs high among a population with an educational level 30% above the U. S. average.

Vepco knows this area intimately. Because Vepco serves it with dependable and abundant electric power . . . 1,700,000 kilowatts of capability now, due to exceed 2,000,000 kilowatts by 1961. For more facts, or confidential site-finding help in this land of mild climate and pleasant living, write or phone today.



50 YEARS 1909-1959

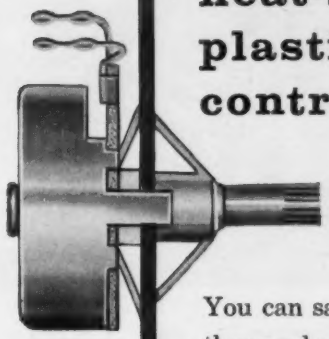
VIRGINIA ELECTRIC and POWER COMPANY

Serving the Top-of-the-South . . . in Virginia, West Virginia and North Carolina

Clark P. Spellman, Mgr., Area Development, Electric Bldg., Richmond 9, Va., MI 9-1411

Save on labor costs

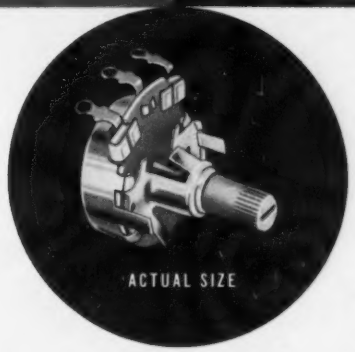
Centralab's heat-stable plastic shaft controls



SNAP into place

You can save on installation costs—up to $10.00 per thousand units—because CENTRALAB Model 2 variable resistors SNAP into position.*

This exclusive "Snap-Tite" design is but one of the many features that make the Model 2 so practical. The thermo-setting plastic shaft is UL approved. You have a choice of six shaft lengths—and the shafts have service adjust screwdriver slots front and rear. The shaft and contact rotor are molded in one piece for rigid, vibration resistant construction.



SPECIFICATIONS

Resistance element: Composition
Resistance range: 250 ohms to 10 megohms
Taper: Available in seven standard tapers
Effective Rotation: 300°
Shaft Lengths: 3/8", 1/2", 5/8", 3/4", 7/8", 1"
Terminals: Standard, plug-in or wire-wrap
***Mounting:** Interchangeable with panel piercing for bushing and twist tab mount

Further information and detailed engineering data available in CENTRALAB Engineering Bulletin EP-815. Write for your free copy.

Centralab CRL

B5971

A DIVISION OF GLOBE-UNION INC.
914K E. KEEFE AVE. • MILWAUKEE 1, WIS.
In Canada: 669 Bayview Ave., Toronto, 17, Ont.

VARIABLE RESISTORS • ELECTRONIC SWITCHES • PACKAGED ELECTRONIC CIRCUITS • CERAMIC CAPACITORS • ENGINEERED CERAMICS

Beattie Oscillotron

DIRECT VIEW

Oscilloscope Recording Camera

Now, get a direct view with both eyes of the cathode ray tube while you're recording. No mirrors — full, clear vision. The new Beattie Direct-View Oscillotron is the most versatile instrument of its kind — actually three cameras in one — and the only system to offer all these important features:

- Direct binocular view of CRT.
- Non-reversed image.
- Camera swings back for easy access to lens and shutter, or lifts off completely. Can be rotated.
- Available with large Polaroid® Land back or electrically-pulsed 35mm or 70mm camera for automatic, remote operation. Adapters for film pack or sheet film available.
- Continuous motion magazines available for 35mm and 70mm models.
- Electric shutter actuator optional with Polaroid® Land model.
- Attaches easily to bezel of 5" CRT. Adaptable to other sizes. No special tools.

"Polaroid"® by Polaroid Corp.

Write today for full details

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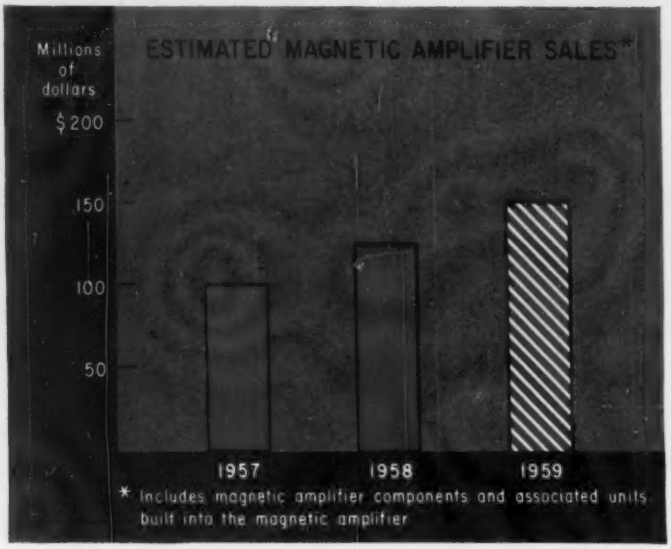


Magnetic Amplifier Sales Rising

TWENTY TO TWENTY-FIVE percent gain in sales of magnetic amplifiers can be expected this year, says Herbert Goldsmith, executive vice president of Magnetic Amplifiers, Inc.

Prediction conservatively translates into a sales estimate of around $150 million for 1959. Sales totaled $125 million in 1958 and $100 million in 1957, Goldsmith and other manufacturers estimate.

Manufacturers look for magnetic amplifier business to multiply a number of times over the next 10 years, assuming continuation of current high level of military spending. Roughly 60 percent of today's business is with the military.

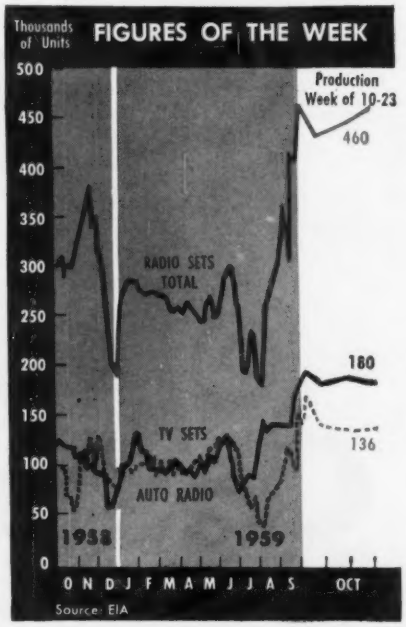
The number of new magnetic amplifiers under development is behind the optimistic outlook for the future.

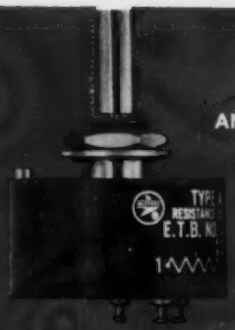
One of these is a subminiaturized solid power supply for use with airborne computers in advanced defense search systems.

Another is a static inverter being developed for use with space equipment. Basic advantage of the new product is its ability to draw power from a solar battery.

Some manufacturers say recent development of low-power units using silicon-controlled rectifiers will open up new markets. In addition to basic magnetic amplifier advantages, the new units offer size reduction and faster speed of response.

• **Du Pont** reduces price of hyperpure silicon single crystals by up to $150 a pound. Firm first marketed single-crystal silicon last year at price of $850 a pound. Today's prices range from $700 to $850 a pound.





ANNOUNCING *the latest important achievement in control system components:*

ACE ELECTRONICS ASSOCIATES, INC.

ACEMHO*

conductive plastic precision potentiometer

INFINITE RESOLUTION
LONGEST LIFE
LOWEST NOISE
EXTREMELY HIGH RELIABILITY

For critical applications where infinite resolution and extremely low operational noise is vital — now there is a superior conductive plastic potentiometer! Ace Electronics Associates, Inc. — specialists in precision potentiometers only — has developed the ACEMHO after more than two years of research. As with other Ace precision potentiometers, it is unsurpassed in lowest noise and longest life characteristics. All of Ace's exhaustive research and development effortr stand behind the ACEMHO as the highest standard of conductive plastic potentiometers in the industry!

Life guarantee: 10 million cycles.
Life expectancy: Tests indicate a 50 million cycle life with noise and resistance change remaining within useful limits. No sudden failure possible due to homogeneous conductive plastic element.

1¼" size condensed specifications: Noise: less than 25 ohms at 1K, less than 50 ohms at 100K. Power Rating: 2 W. @ 20°C, 2K and up. 3 W. @ 20°C below 2K. Operating Temperature Range: —55°C to 125°C. Resolution: Essentially infinite — 0.005°. Torque: 0.5 inch-ounces maximum. Contact Resistance: lowest available in conductive plastic. Meets all applicable MIL spec's. Completely shock, vibration and acceleration resistant. In a series of standard resistance ranges.

Also available in ½", ⅜" and rectilinear.

Full engineering specifications upon request. Call, telegraph or write with your engineering sample requirements. Prompt delivery of prototypes.

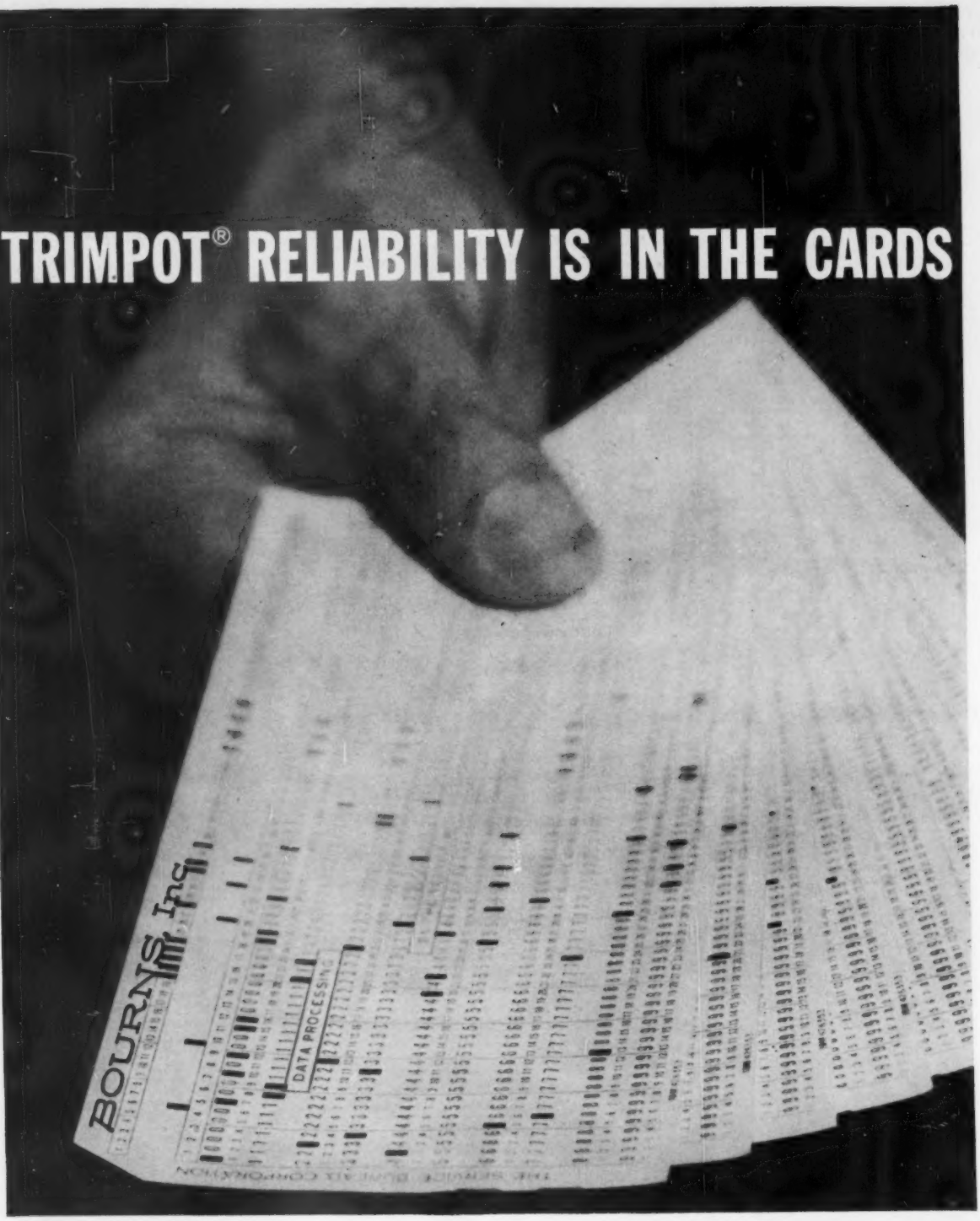
*Reg. applied for—Patents Pending

ACE ELECTRONICS ASSOCIATES, INC.

[illegible] Street, Somerville 44, Mass. Tel: SOmerset 6-5130 Western Union: WUX Somerville, Mass.

Representatives in all principal cities

TRIMPOT® RELIABILITY IS IN THE CARDS



Test information punched in these cards can provide detailed performance reliability statistics on Trimpot production. The cards summarize extensive environmental tests which Bourns regularly conducts above and beyond regular quality control. In Bourns own Reliability Assurance Laboratory, monthly samples are taken at random from factory stocks and completely tested for conformance to all environmental and electrical specifications on Trimpot catalog sheets. Results can then be fed into IBM computers which analyze performance data with corrective action taken immediately, if required!

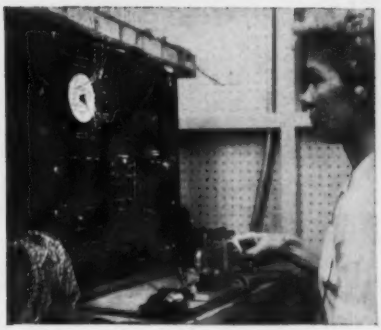
This program is the only one of its kind in the industry. Only Trimpot potentiometers are tested so thoroughly, so frequently. In short, Trimpot reliability is a fact—one you can put in your next circuit.

PUNCHED CARDS ARE USED TO TABULATE BOURNS RELIABILITY DATA FROM –

Complete Quality Control Like This...

Trimpot reliability starts at the beginning. Here an incoming lot of potentiometer lead-screws undergoes a dimensional check.

From the time the element is wound until the lid of the potentiometer is installed, in-process inspection monitors quality.



100% final inspection is made possible by this exclusive high-speed system developed by Bourns to test all major electrical characteristics. Critical dimensions of each unit are also checked.

And Reliability Assurance Tests Like These...

This vibrator for measuring conformance to Mil-Specs is an important part of the extensive equipment in Bourns Reliability Assurance Laboratory.

This chamber subjects potentiometers to standard military tests for humidity, provides important feedback on product performance.

1000-hour load life testing per Mil-R-19A takes place in ovens like this, which hold temperatures at desired levels at full rated power.

When tests are completed and the results tabulated, Bourns engineers plot frequency distribution curves from the steady flow of test results. Analysis of these curves and other data from testing provides a continuing check on all models to see that they meet the most exacting standards of performance. This analysis and the constant flow of information between the Testing and Production departments is your assurance that the Trimpot potentiometers you specify and purchase will meet specifications.

Write for the new 8-page folder describing the Bourns Reliability Assurance Program and a copy of the Trimpot Summary Brochure.

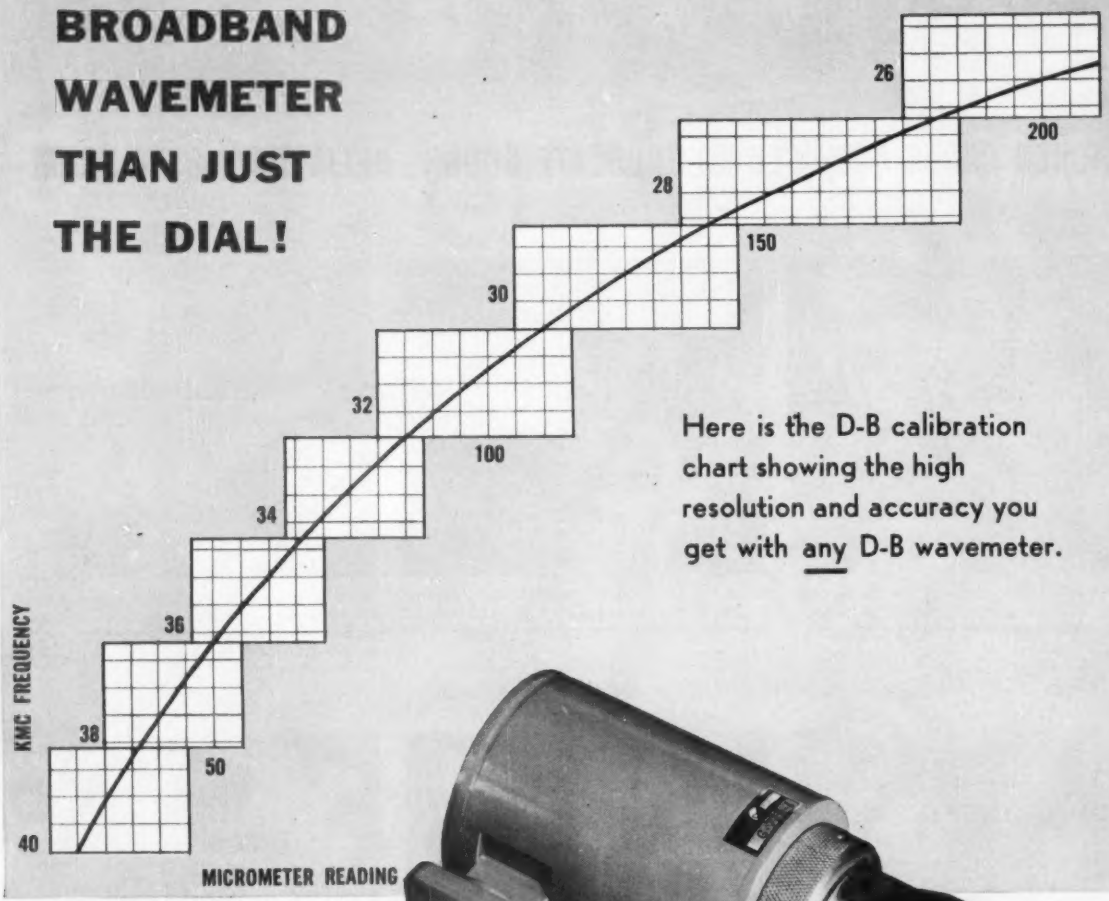
BOURNS
Inc.

P.O. Box 2112R, Riverside, Calif.
Plants: Riverside, California
and Ames, Iowa

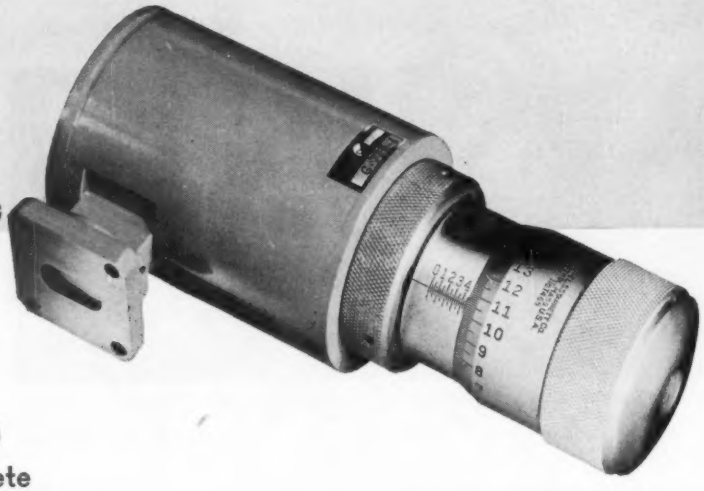
Exclusive manufacturers of TRIMPOT®, TRIMIT®. Pioneers in potentiometer transducers for position, pressure and acceleration.

CIRCLE 33 ON READER SERVICE CARD

THERE'S MORE TO A D-B BROADBAND WAVEMETER THAN JUST THE DIAL!



Here is the D-B calibration chart showing the high resolution and accuracy you get with any D-B wavemeter.



Twelve models cover from 2.6 KMC to 140 KMC. Write for complete data in Bulletin D-B 715.

DE MORNAY-BONARDI

DE MORNAY-BONARDI
780 SOUTH ARROYO PARKWAY • PASADENA, CALIF.

Test your Transistor I.Q. with this quick quiz:

1. What are the six main types of transistor computer logic?
2. What are the methods for servicing and aligning a transistor radio?
3. How is a transistor bias circuit designed taking into account variations of beta, I_{CO}, V_{BE} and temperature?
4. How are common base h parameters converted to common emitter h parameters?
5. What is the difference between an alloy diffused transistor and a drift transistor?
6. What circuit can be used for a 2 KW regulated power supply using silicon controlled rectifiers?
7. What circuit can be used for a transistor sawtooth generator with a 0.3% linearity?
8. Can a simple bass-boost circuit be designed to compensate for changes in output level of a phono preamplifier without lowering its sensitivity?
9. What are the major factors influencing transistor reliability?
10. What is the collector leakage current in a common emitter transistor when the base is reverse biased?

If you can't answer all of these questions, don't be discouraged. Help is at hand! Just get yourself a copy of the big new 4th Edition of General Electric's famous TRANSISTOR MANUAL. Its 227 fact-filled pages contain the answers to all these questions—and many, many more. There are 60 more pages, 7 more chapters and 23 additional circuits!

This is the one book in the transistor field you can't afford to be without—constantly kept up-to-date to help you stay abreast of the latest developments. Your General Electric Tube Distributor has them, or mail the coupon at right.

General Electric Company
Semiconductor Products Dept., Section S24119
Electronics Park, Syracuse, N. Y.

Rush me the enlarged 4th Edition of General Electric's Transistor Manual. I enclose $1.00. (No stamps, please.)

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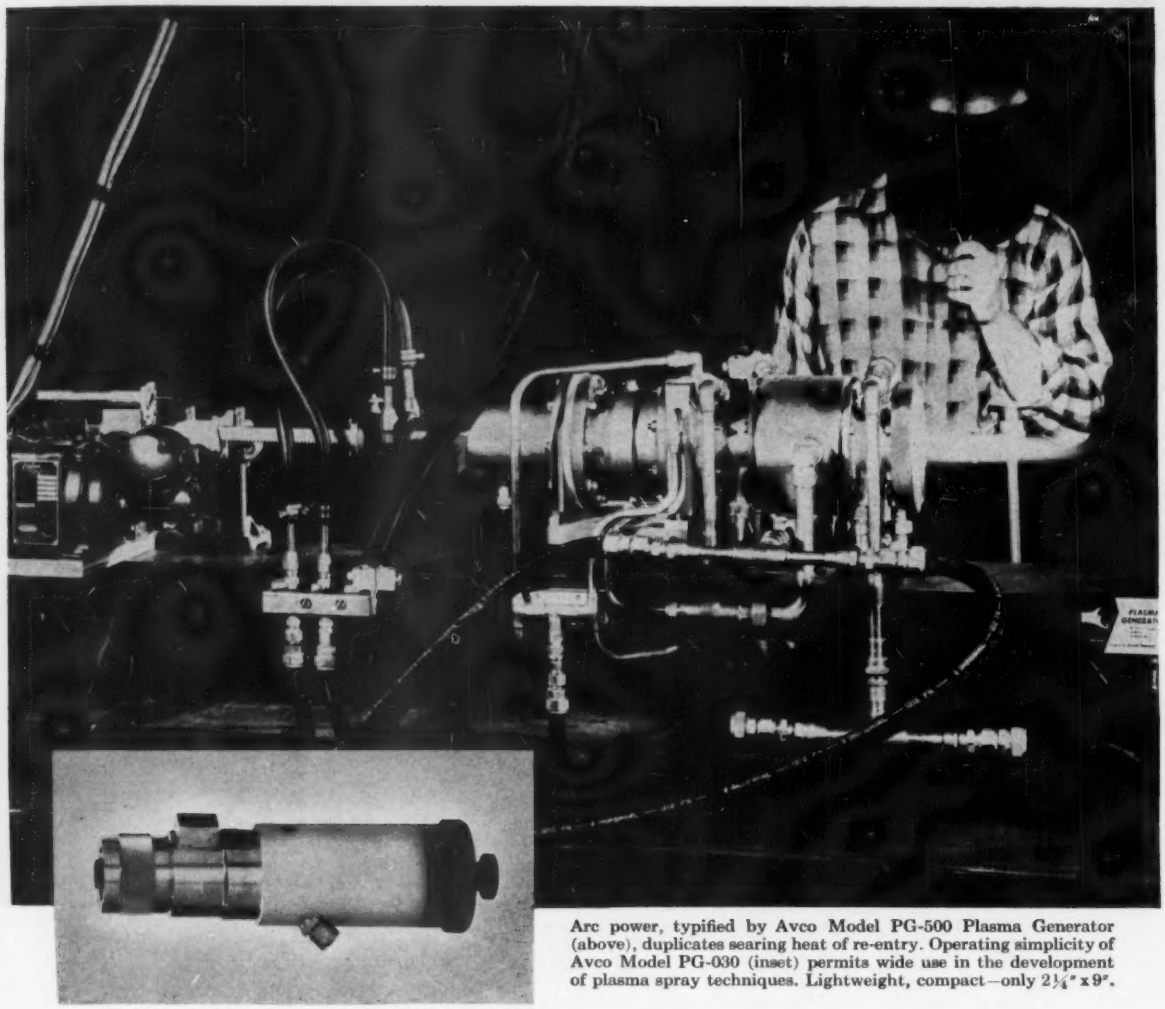
GENERAL ELECTRIC



Arc power, typified by Avco Model PG-500 Plasma Generator (above), duplicates searing heat of re-entry. Operating simplicity of Avco Model PG-030 (inset) permits wide use in the development of plasma spray techniques. Lightweight, compact—only 2¼" x 9".

NOW AVAILABLE...

USE-PROVEN PLASMA GENERATORS that duplicate the searing heat of re-entry

Avco Model PG-500 Plasma Generator, operating at one atmosphere of pressure, produces enthalpies from 250 to 12,500 Btu/lb, consumes up to 1.5 megawatts of power, uses air as the working fluid and incorporates over two years of re-entry simulation experience. PG-500, producing heat fluxes and temperatures on a *continuous* basis formerly attained on an intermittent basis in the shock tube, now provides the long running times in air necessary for materials development.

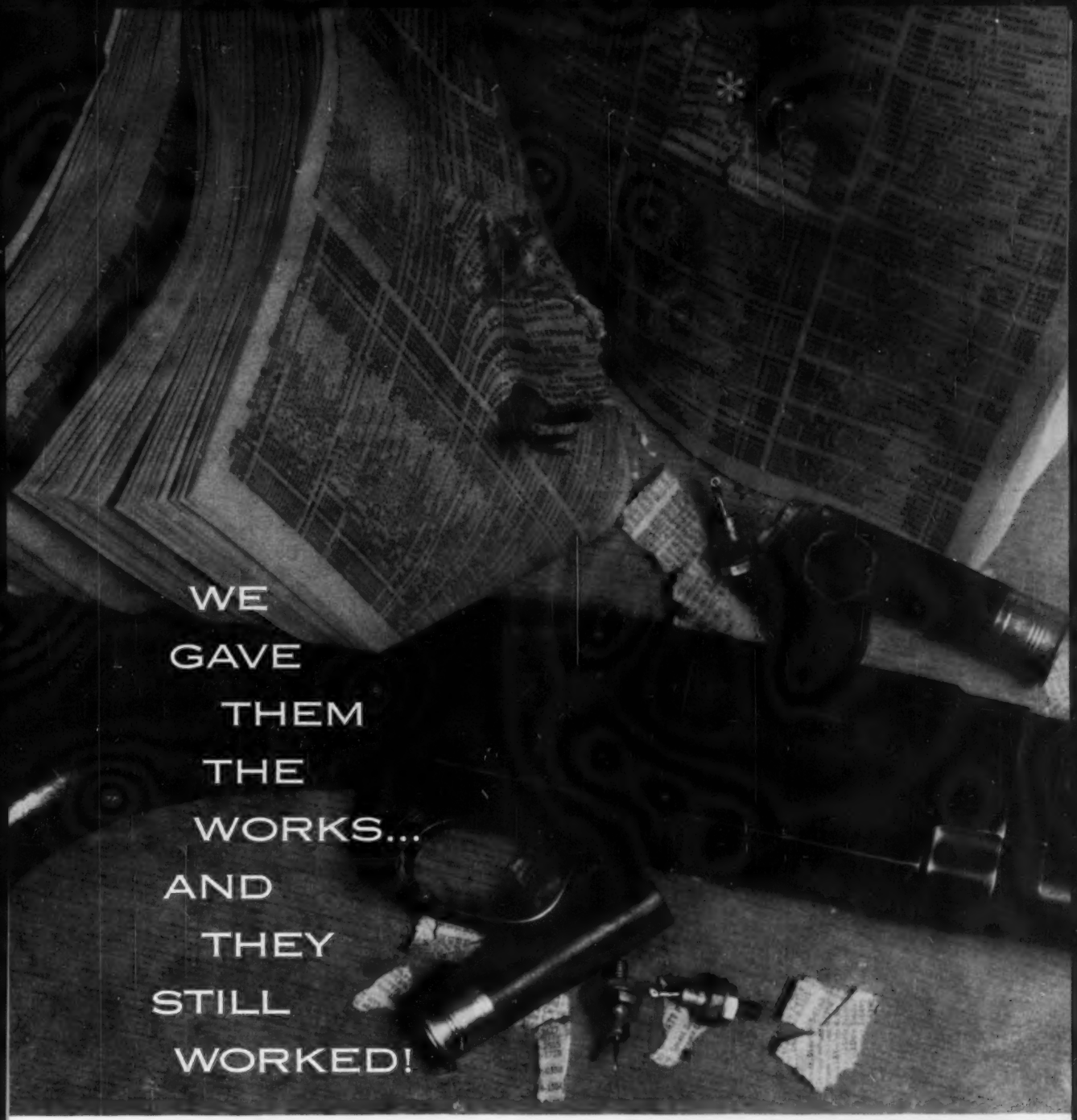
Another unit in the Avco-developed family of plasma generators, Model PG-030, consumes from 2 to 20 kilowatts of power and produces temperatures over the range from 2500°F. to 12,000°F. Model PG-030 is used for development of plasma spray techniques and spectroscopic studies. Using argon as the working fluid, it is capable of virtually unlimited operation at a power level of 15 kilowatts. Model PG-030 is especially suited to low cost operation and features automatic starting, a high degree of controllability, quiet operation and shop-type reliability.

Write for bulletins describing Avco's products and systems in the fields of Major Research Facilities, Hypervelocity Instrumentation and Environmental Test Equipment. *Write to: Products and Services Dept., Research and Advanced Development Division, Avco Corporation, 201 Lowell St., Wilmington, Mass.*

Avco

Research & Advanced Development division

CIRCLE 37 ON READER SERVICE CARD→



After being blasted out of a shotgun into a telephone directory, these International Rectifiers tested out to published specifications. Shock-resistant ruggedness like this is just one distinguishing feature of the reliability you can depend upon when you specify any International Rectifier.

* *If you were wondering, they reached page 772 of the phone book. And if your curiosity about International Rectifiers goes even deeper than that, a note on your company letterhead will put you on our monthly Rectifier News mailing list.*

INTERNATIONAL RECTIFIER CORPORATION

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281

WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS • SELENIUM • GERMANIUM • SILICON

OFFICES AND REPRESENTATIVES THROUGHOUT THE WORLD

Hughes-Fullerton can offer you a uniquely productive, engineering-oriented position...where you'll find unequalled room to expand professionally.

A big promise. But let the facts speak:

Creative Atmosphere—Engineers are encouraged to do independent thinking. The many Hughes-Fullerton "breakthroughs" are testimony to this creatively unhampered atmosphere.

Research and Development Orientation—Because the bulk of Hughes-Fullerton projects start from "scratch," engineers have the satisfaction of being in on advancements in the state-of-the-art. At the same time, they can see that the final product fulfills program needs.

Long Range Projects—Hughes was first to develop three dimensional radar. Today this work is expanding to encompass highly advanced data processing systems and electronic display systems.

Privacy—At Hughes-Fullerton, engineers enjoy private or semi-private offices in new air conditioned quarters.

Growth of Opportunity—Hughes-Fullerton (30 minutes from downtown Los Angeles) has grown from 800 employees in 1957 to 5,000 today. This programmed growth means unusual advancement opportunity. Engineers' average age: 31. One out of five has an advanced degree.

It will pay you to investigate Hughes-Fullerton as the place to further develop your career as an engineer—no matter what your experience level. Please call or write to Mr. E. P. Ramstack, Director of Professional Placement, at the address below.

HUGHES

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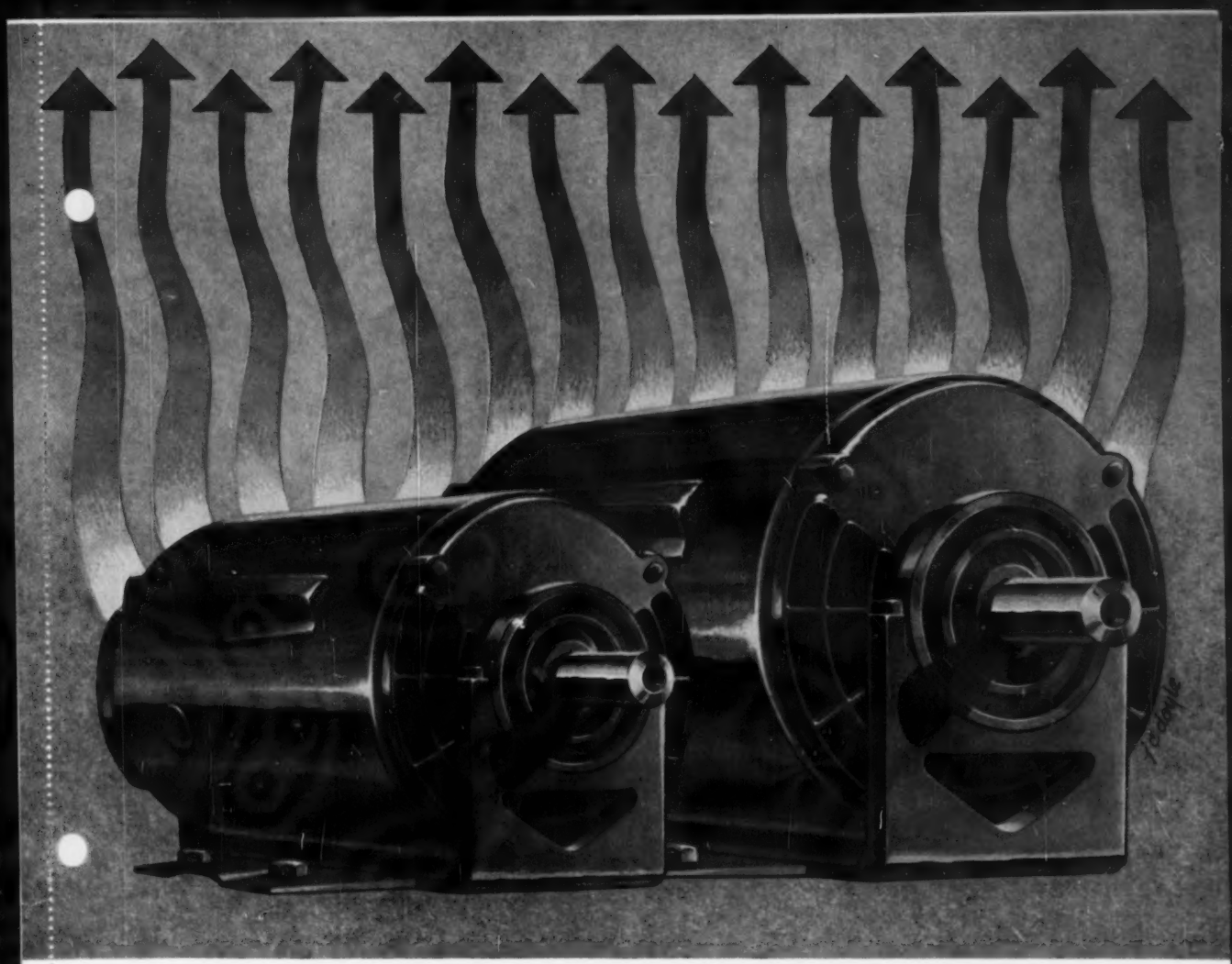
FULLERTON-RESEARCH & DEVELOPMENT, FULLERTON, CALIFORNIA

electronic engineers:

cut off from creativity?

CIRCLE 39 ON READER SERVICE CARD→



WHEN WINDINGS MUST RUN HOT—GET MORE HP PER POUND WITH 155°C ANATHERM MAGNET WIRE

ANATHERM—a polyester film-coated wire enables you to build a smaller motor without reducing horsepower output—enables your customers to operate motors at higher temperatures without loss of horsepower. In fact, wherever magnetic windings must run hot, Anatherm offers similar advantages.

But this is only part of the reason why Anaconda Anatherm has found such wide acceptance. Its greater thermal stability—plus excellent abrasion resistance, chemical stability and dielectric strength—help make Anatherm ideal for a wide variety of applications.

Anatherm—the first film-coated magnet wire to qualify for the AIEE Class F (155°C) rating has been field-tested and proved. Our broad application experience with Anatherm allows us to offer this wire in Sizes 8 to 46 in standard film thicknesses, and in a full range of round, square and rectangular sizes.

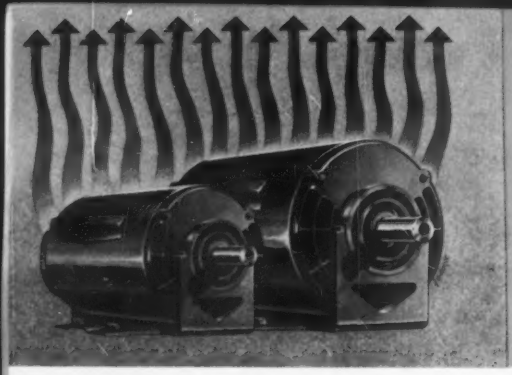
For more information, see the Man from Anaconda. Look up "Anaconda" in your phone book—in most principal cities—or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y. 89350

ASK THE MAN FROM

ANACONDA®

ABOUT ANATHERM MAGNET WIRE

For you, Anatherm can mean smaller electrical equipment . . . higher operating temperatures. See details on reverse side.



MAGNET WIRE DATA SHEET

from

Anaconda Wire & Cable Co.

IMPORTANT FACTS FOR YOUR WORK...

...about Anatherm 155°C (AIEE Class F) Magnet Wire

When proper advantage is taken of Anaconda Anatherm's higher 155°C characteristics, electrical equipment can be improved in these ways:

RAISES LIMITING OPERATING TEMPERATURES. Anatherm raises limiting operating temperatures to 155°C. This high heat resistance means extra protection . . . longer equipment life . . . wider range of applications.

REDUCES FRAME SIZE. Anatherm gives more horsepower from the same space or the same horsepower from a smaller motor. Costs are cut for you, and your customers benefit from smaller over-all components.

INCREASES HORSEPOWER RATINGS. Anatherm is the best of the polyesters. Its high heat resistance means higher permissible operating temperatures, greater horsepower rating.

UPGRADING. Anatherm helps upgrade standard equipment. Gives added heat insurance through thermal stability. Particularly suited for overloads.

COMPATIBILITY. With polyesters, importance must be placed upon a completely compatible system. Varnish manufacturers have recently developed polyester varnishes which allow a compatible polyester magnet wire system. A number of varnishes other than polyester are compatible with Anatherm, but consultation with varnish suppliers before use is recommended.

TECHNICAL PROPERTIES

MECHANICAL PROPERTIES

Anatherm has unusually high abrasion-resistance. This characteristic allows it to be wound on both conventional and automatic winding equipment. Anatherm offers excellent flexibility and adherence properties. It meets NEMA snap test requirements and exhibits excellent adherence to the conductor.

ELECTRICAL PROPERTIES

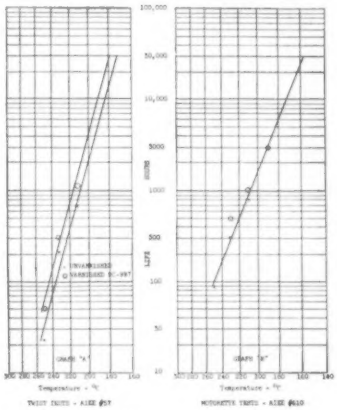
Anatherm maintains its dielectric strength under prolonged heating at high temperatures. It consistently exceeds dielectric strength requirements for NEMA dielectric twist test.

CHEMICAL PROPERTIES

Anatherm will resist toluol, VM & P Naphtha, Ethyl Alcohol and 5% Sulphuric Acid. Anatherm is a polyester and exhibits the best characteristics of this class of chemical compound. However, all polyesters must be used with certain precautions where moisture and/or enclosed systems are concerned. Similar precautions must be taken where chlorine-base supporting insulations, such as neoprene and polyvinyl chloride, are present. Polyesters should not be used in applications subject to exposure to concentrated alkalies.

THERMAL PROPERTIES

Anatherm is offered as a 155°C (AIEE Class F) magnet wire based on AIEE #57 and #510 test methods. These tests, performed by Anaconda engineers, show Anatherm as being capable of a 30,000-hour life at 157°C in an unvarnished state and the same life at 175°C when treated with a silicone or polyester type varnish. Thus Anatherm, when suitably varnished, has reserve stability even above the 155°C rating at which it is being offered. The thermoplastic flow temperature for Anatherm, based on MIL-W-583A, is very high (250°C). Anatherm also shows outstanding retention of flexibility after aging. Wire can be heated 168 hours at 175°C and then wound on three times its own diameter without cracking. Its heat-shock characteristics are exceptionally good for a polyester wire: Anatherm will withstand a 1x mandrel wrap at 155°C for one hour.



ANATHERM MAGNET WIRE

TEAR OUT FOR YOUR FILE

E

ANACONDA WIRE & CABLE COMPANY
25 BROADWAY, NEW YORK 4, NEW YORK

Please send me a copy of your Anatherm Magnet Wire Booklet.

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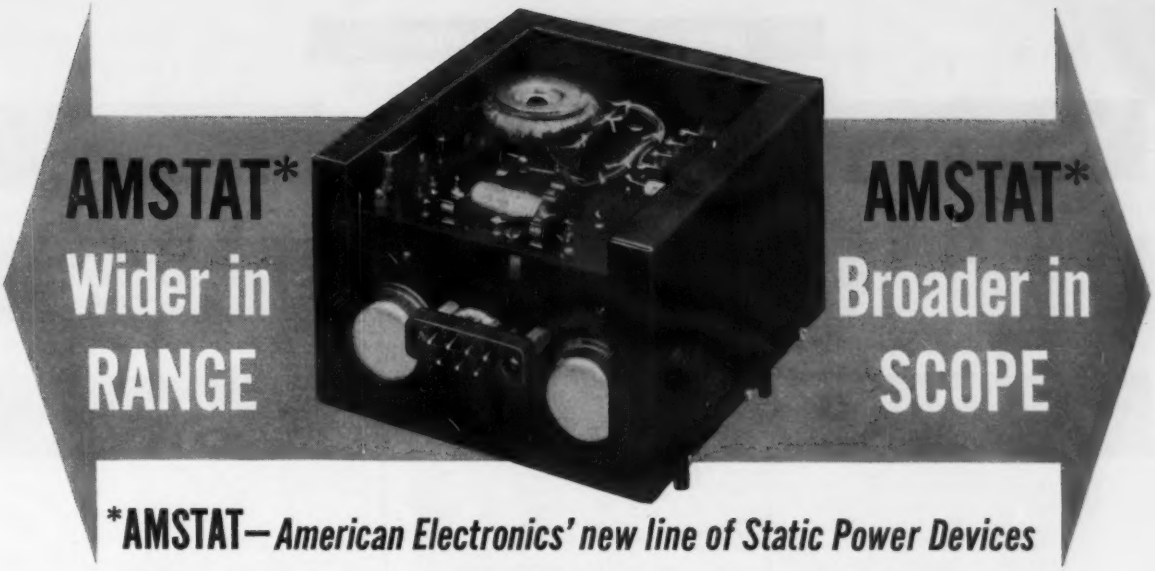
Valuable Anatherm Magnet Wire Handbook—
yours for the asking!
Latest information . . . full technical data.



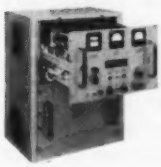
*AMSTAT—*American Electronics' new line of Static Power Devices*

WIDER IN RANGE—*offering units with the widest rating range available in the industry—10VA to 3000 VA—50C to 6KC—single and three phase.*

BROADER IN SCOPE—*opening new applications for the desirable features of static power devices with a complete line of Inverters, Frequency Changers and Converters in Transistor and Silicon Controlled Rectifier units.*

American Electronics, Inc., through its Electric Machinery and Equipment Division, now offers one dependable source for a complete line of solid-state power converting devices. Their outstanding performance characteristics are unique in the industry, including operation to zero load...operation with leading and lagging power factor loads and with highly unbalanced loads. Advanced design features such as spike suppression, inherent short-circuit proof circuitry, and greater tolerances to heat, assure longer unit life and unmatched reliability.

Only part of the AMSTAT story can be told in this limited space. For complete information on American Electronics' new line of Static Power Devices, please write:



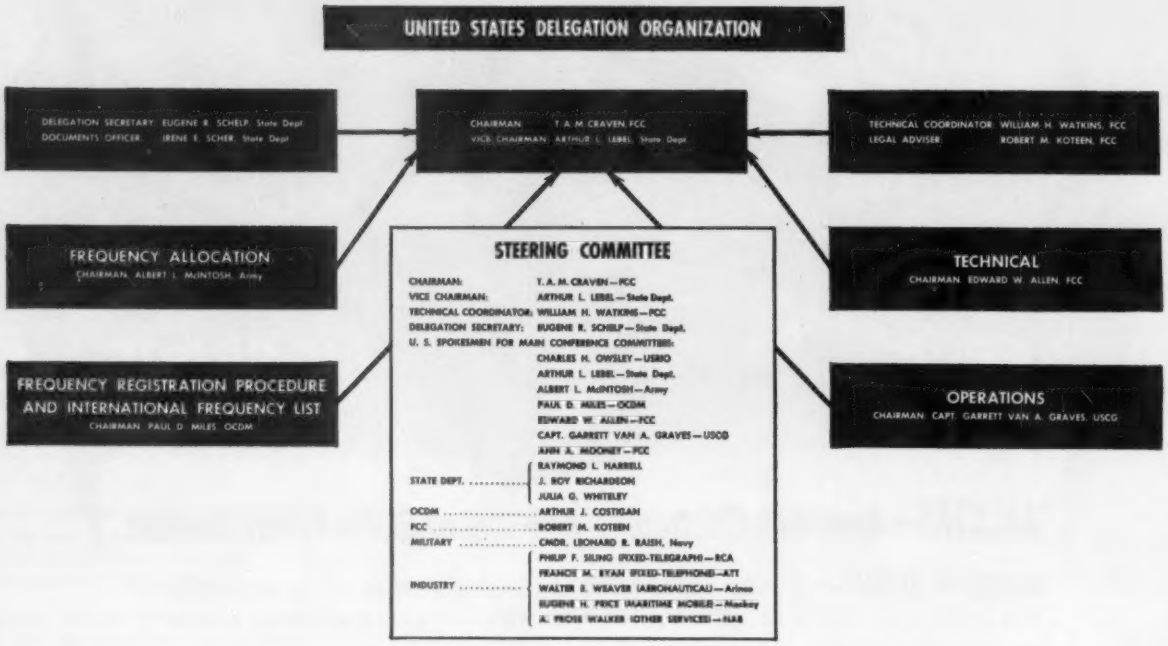
Model 8254VR Silicon Controlled Rectifier Frequency Changer for Laboratory Use.

AMERICAN ELECTRONICS, INC.

ELECTRIC MACHINERY & EQUIPMENT DIVISION

2112 NORTH CHICO AVENUE, EL MONTE, CALIFORNIA • CUMBERLAND 3-7151

MODEL NO.	DESCRIPTION	OUTPUT			INPUT VOLTAGE		MAX. AMBIENT TEMP. (Operating)	REMARKS
		VA	VOLTS	Freq CPS	Nom.	Range		
8251VT	Inverter, 1 ph	100	115 V	400	28 VDC	26-29 VDC	—54°C to 71°C	Square wave output. Frequency and voltage unregulated.
8252VT	Converter, 1 ph	100	6.3 VAC, 6 amps 400 VDC, 75 ma 150 VDC, 120 ma	1200 DC DC	28 VDC	25-31 VDC	—54°C to 71°C	Regulated and filtered DC outputs.
8253VT	Inverter, 1 ph	100	117 V	400	28 VDC	26-31 VDC	—54°C to 71°C	Sine wave output. Frequency and voltage regulated.
8254VR	Frequency Changer, 1 ph	500	105-125 V adj.	360 to 440 adj.	115 VAC	105-125 VAC	40°C	Sine wave output. Frequency and voltage regulated. Silicon controlled rectifier unit.
8255VT	Inverter, 3 ph	200	115/200 V	400	28 VDC	26-29 VDC	—54°C to 71°C	Stepped voltage wave output. Frequency regulated. Voltage not regulated.
8256V	Filter Pack, 3 ph	200	115/200 V	400	28 VDC	26-29 VDC	—54°C to 71°C	Sine wave output. Frequency, but not voltage regulated.
8257V	Regulator Pack, 3 ph	100	115/200 V	400	28 VDC	26-29 VDC	—54°C to 71°C	Frequency and voltage regulated.
8258VR	Inverter, 1 ph	500	115 V	400	28 VDC	26-29 VDC	65°C-500VA 85°C-300VA	Sine wave output. Voltage and frequency regulated. Silicon controlled rectifier unit.
8259VR	Inverter, 3 ph	1500	115/200 V	400	28 VDC	26-29 VDC	65°C-1500VA 85°C-1000VA	Sine wave output. Voltage and frequency regulated. Silicon controlled rectifier unit.
8260VR	Inverter, 3 ph	1000	115/200 V	400	28 VDC	26-29 VDC	85°C Max. MS 33543 Curve I	Sine wave output. Voltage and frequency regulated. Silicon controlled rectifier unit. Class H insulated magnetic components.
8261VR	Frequency Changer, 3 ph	3000	115/200 V	400	117 VAC	105-125 V 320 to 480 cps	65°C-3000VA 85°C-2000VA	Sine wave output. Voltage and frequency regulated. Silicon controlled rectifier unit.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Geneva Parley Picks Up Speed

U. S. proposals at international radio conference reflect expanding requirements posed by space age and by technology

DEFINITIONS of some of the major points for discussion at the International Telecommunications Conference going on in Geneva, Switzerland, are beginning to take shape this week.

Some of these are:

• New developments in technology plus new interest in space explorations are going to be a headache to "big nation" members, and may be largely ignored by "small nations".

• Although some East-vs-West coalitions are becoming evident, the number of new nations formed in the years after World War II may serve as a damper to wide variations in viewpoint. At the final voting, each member nation gets one ballot. Territories each get a ballot on a separate basis. This gives USSR a certain advantage, but U. S. officials say it won't be significant.

• The shape and responsibilities of the different committees has been established, and this month will see the formulation of recommendations to the main Plenipotentiary Conference, responsible for drawing up the final agreements which bind the Union members.

United States participants functioning at all these levels presently number close to 100. Under the sponsorship of the State Department, the group is headed by Commissioner T.A.M. Craven of FCC.

Firms Send Men

Eleven American companies have released personnel to form part of the U. S. delegation. While serving in Geneva, these men are acting as U. S. citizens, not as employees of their respective companies.

Also with the Geneva group are 18 members of FCC and officials of the armed forces, Treasury, State Defense and Commerce Departments, as well as USIA, OCDM and NASA representatives.

ELECTRONICS' talks with spokesmen for the group indicate that developments will be made slowly.

Major reason for this has been the tremendous expansion in electronics knowledge that has taken place since the last conference. Such developments as single sideband transmission, over-the-horizon microwave broadcasting, radar and space programs will, according to men at Geneva, present a great challenge to the judgment of the Conference.

U. S. proposals to the Administrative Radio Conference advise a slow approach to any change. The position on this is that certain new aspects introduced at the last major conference have not yet been operational long enough to permit proper evaluation. Our representatives express the wish to guard against the financial hardship and technical difficulties that may arise from premature recommendations.

U. S. Proposals

In areas other than the workaday broadcasting frequencies now in international use, however, the U. S. group has urged the close attention

of the conference. In discussing the frequencies above 25 mc, for example, the U. S. proposal calls for provisions on a shared or exclusive basis for aeronautical mobile, earth-space, fixed mobile and radio positioning.

They have also asked the Conference to consider the possible need for provision of frequencies between 150 and 1,700 mc for new developments in space and earth/space transmissions. Our delegation has pointed out that provision for relay transmissions using space satellites as repeaters is not contemplated in their proposals which are limited to operational or functional uses of radio having to do with objects in space.

Another proposal in the 529-page U. S. presentation states "it is urgent that adequate exclusive space be provided in suitable parts of the radio spectrum for the development and operation of satisfactory air navigation aids."

This section stresses the great need imposed on present air-safety operations by the greater numbers and speeds of aircraft.

'Gratifying' Aspects

One aspect of the conference termed "gratifying" by a spokesman for the National Academy of Science centers around an original U. S. proposal on spectrum space for radio astronomy. Our group had planned to ask that 1,427 mc be set aside for radio telescopes.

Radio astronomers, fearful of spectrum shortage for space exploration called on the State Department for action on Oct. 16. One Academy official told ELECTRONICS that a meeting was convened almost immediately.

By late Saturday, Oct. 17, the Washington group accomplished its purpose with the result that the U. S. proposed at least seven radio astronomy bands in the 40-to-1,537-mc range by Oct. 18.

Present schedules call for the conference to conclude by mid-December, but many delegates express the opinion that it will run over into the beginning of 1960.

In accordance with terms of the treaty which originally formed the ITU, recommendations made at this year's conference will be slated to go into effect by January 1, 1961.

Test Global Weather System

Recent flight experiments may open new way of keeping tabs electronically on weather

RECENTLY COMPLETED flight tests of Global Weather Reconnaissance system, shown here aboard a Boeing 707, demonstrated the feasibility of the system, reports prime contractor Bendix (ELECTRONICS, p 28, Sept. 19, '58; p 26, Jan. 16, '59).

Designated AN/AMQ-15, the system was tested as a cooperative experiment between USAF, Navy, Weather Bureau, Bendix and Boeing.

The AMQ-15 collected and processed data received from other aircraft, dropsondes and rocketsondes in the area. Navy sent up an A3D aircraft instrumented for high altitude meteorological research; USAF, a WB-57 equipped with sensors and parachute-borne dropsondes. Rocketsondes were ground-launched from New Mexico and from the 707 to collect data at 170,000 ft.

More tests are planned as part of the 3-year program.

Chicago Buses Try Interrogator Units

CHICAGO—The Chicago Transit Authority has authorized payment of $50,000 for test installation here of interrogator units for buses.

Purchase contract is with the Western Railroad Supply Company.

First installation will cover 40 shuttle buses operating between Chicago's Merchandise Mart and the Stadium at Soldiers Field.

Wire loops 8 to 12 ft long will be imbedded in the pavement from one side of the street to the other. Interrogator units will be mounted on short poles at curb locations.

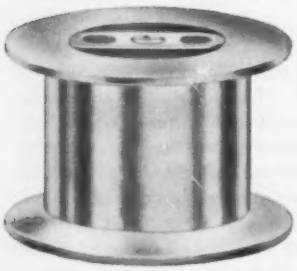
Each bus will carry a response block 4 in wide and 1 in thick. Drivers will carry this on and off buses in their pockets. Interrogator units will be connected by wire to pavement loops and energized.

As buses enter various magnetic fields thrown through a limited area by pavement coils, blocks will send a coded signal telling identity of the individual buses. Interrogator units will relay information by telephone wire to the CTA dispatchers office.

ELECTRONICS PROGRESS THROUGH CHEMISTRY AND METALLURGY

*From actual Photomicrographs (375X)

This is stretching it pretty fine!



• Drawing extremely fine wire in large quantities and to close tolerances is a fine art at Sylvania. It is also a scientific business, largely because Sylvania engineers designed their own precise machines and methods that carry out the many operations from heavy swaging to final spooling.

One ten thousandth inch diameter is about as fine a tungsten wire as any Sylvania customer has needed so far . . . molybdenum down to .0005" . . . and that is something of a record in fineness! Sylvania wires of exceptionally small diameters are playing a vital part in further reducing the dimensions and fostering new design concepts of electronic tubes. When even finer wires are required, Sylvania will be ready to produce them!

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SMALLEST LIGHTEST CARCINOTRONS

with wide band sole tuning

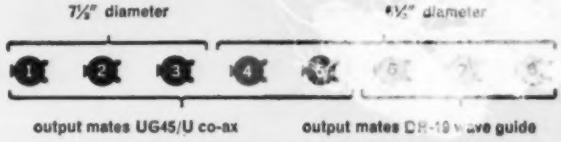
Though it has just recently made its debut into the high society of Litton microwave tubes, this carcinotron (our model L-3298) has already been commended by the military for its exceptionally clean design. Every engineer concerned with upgrading the performance of ECM equipment will surely find much of interest in this medium-power tube, with which Litton takes a major stride toward truly simultaneous noise-jamming capability by affording faster tuning rates than any previously attainable.

The Litton family of eight electrically-compatible carcinotrons is the first to incorporate the critical capability of wide band sole tuning without frequency or power holes when the tube is operated into as much as a 1.5-to-1 mismatch. Litton carcinotrons are the first to use wider-than-normal-band RF output couplers, minimizing many system components such as antennae, waveguide plumbing, and load isolators.

We cite these firsts not for glory's sake, but rather for their meaningful contribution to more efficient system design, smaller size and lighter weight.

The notable suitability of these carcinotrons is not limited to ECM. You can also consider them for other military applications such as drivers for communications links—in fact, wherever medium-power tubes with extremely rapid tuning and low tuning power are required.

Because of their mechanical and electrical compatibility the eight tubes in the family are interchangeable as shown.



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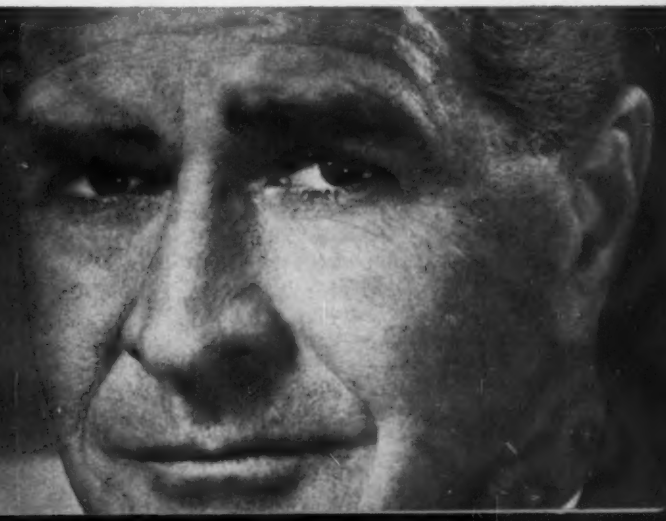
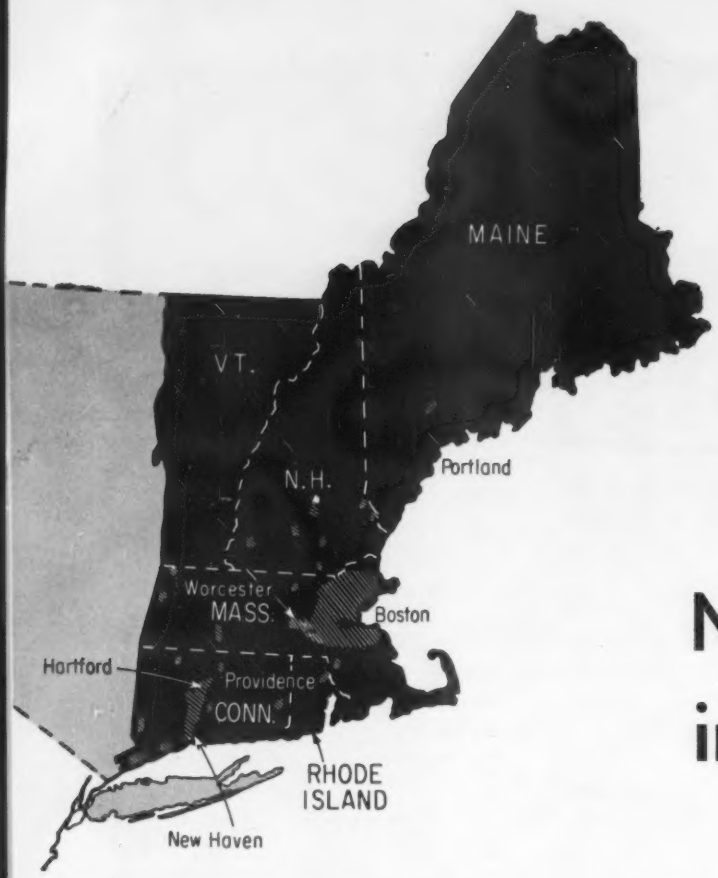




Northeast stages its biggest show next week in Boston. Area approaches 1960s with reinforced R&D strength, expanding production in new areas

New England in Ferment . . .

BOSTON—AGAINST A BACKGROUND of New England electronics in ferment, the Northeast Electronics Research and Engineering meeting (NEREM) will be held next week at Commonwealth Armory here. The meeting opens Tuesday, runs through Thursday.

Proclaimed the third largest electronics show in the U. S. with 315 booths and a 10 percent waiting list, NEREM 1959 is expected to draw 10,000 visitors.

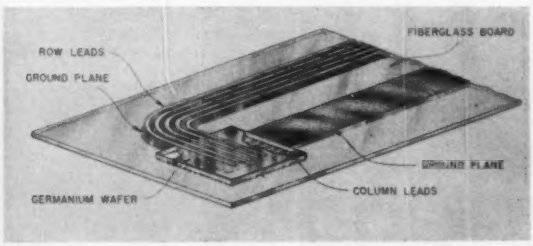
In the most ambitious technical program in the history of NEREM, 76 papers will be presented, supplemented by in-plant technical workshops in radio astronomy and Doppler techniques, and a tutorial session on plasma research.

Big-Dollar Electronics

NEREM is sponsored by the Boston, Western Massachusetts and Connecticut sections of IRE, with participation also by upper New York. The exhibits and program, weak in the tv-radio field, are strong in the big-dollar part of electronics. Heavy emphasis is on instrumentation and components for high-precision advanced research equipment.

NEREM will be staged against a backdrop of a New England electronics industry which is keyed to the seething '60s, a decade expected to develop three significant trends: intensification of the area's R&D strength, extension of production lines into relatively untapped labor areas where textiles once flourished, and exploitation of foreign markets.

James R. Killian, Jr., chairman of the MIT corporation, recently noted that New England has a unique concentration of educational, research and industrial resources to help create and shape the "scientific revolution," the systematic application of real science to industry.



Cryosar, new semiconductor switching device developed at MIT Lincoln Lab, operates at liquid helium temperatures, has switching time less than 10 millimicro seconds. Left: front and back views of an experimental matrix array of 1024 cryosars on a ¼-sq-in germanium wafer 0.005 in thick. A switching element is located at each point where a vertical line on the front crosses a horizontal line on the back. Lines are electrical conductors of aluminum evaporated on the surface and allowed into the germanium to form ohmic contacts. Above: sketch shows possible method, using printed circuit techniques, for incorporating a cryosar array into associated circuitry

Among manifestations of the ferment that is going on in electronics education and R&D are the Ford Foundation grant of $9,275,000 to MIT for sweeping changes in the approach and content of engineering education; upgrading of AF Cambridge Research Center at Bedford, Mass., as headquarters for all Air Force research on communication and electronic control systems; and arrival of outside firms, most recently AC Spark Plug and Aeronutronics, to set up advanced research branches.

Simultaneous with intensification of research activity in the Boston-Cambridge-Route 128 area is extension of production facilities into New Hampshire, Maine and Rhode Island. In many cases it is strictly an extension, with administrative and engineering functions remaining in the Massachusetts "electronics heartland."

Focal point of expansion is lower New Hampshire, where textile-tinted names like Nashua and Manchester are now identified with electronics.

Key factors are: saturation of the electronics labor market in the Newton-Waltham area of Massachusetts and along Route 128; lower wage cost factors; government encouragement of industries to decentralize; and explosive expansion of suburban Boston.

"With the new highways, Nashua has become a suburb of Boston," says the v.p. of a Cambridge firm which is shifting production to New Hampshire. This company also feels that engineering and production "require two different types of atmosphere and thinking."

New England's research depth makes it highly likely that giants will be nurtured in the area, "sleepers" who will be hardly noticed until they emerge at the top.

Sales Top $1.25 Billion

Industry estimates indicate that New England in 1959 will produce more than $1.25 billion in gross factory sales of electronic products, approaching 15 percent of the $9 billion national gross.

New England electronics employs more than 115,000 in 600 plants, is sure to overtake textiles in the 1960s to rank as third largest employer, behind non-electric machinery and electric machinery.

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	HAR3K/2	3000vdc @ 2ma	4⅝ x 4 x 6	260.00
	HAR5K/2	5000vdc @ 2ma	5 x 4¼ x 6¾	315.00
High Voltage DC Output, DC Input (26-29VDC)	HDR1K/2	1000vdc @ 2ma	3½ x 3 x 4⅞	195.00
	HDR3K/2	3000vdc @ 2ma	4 x 3⅜ x 5¼	245.00
	HDR5K/2	5000vdc @ 2ma	4¼ x 3⅝ x 5½	295.00

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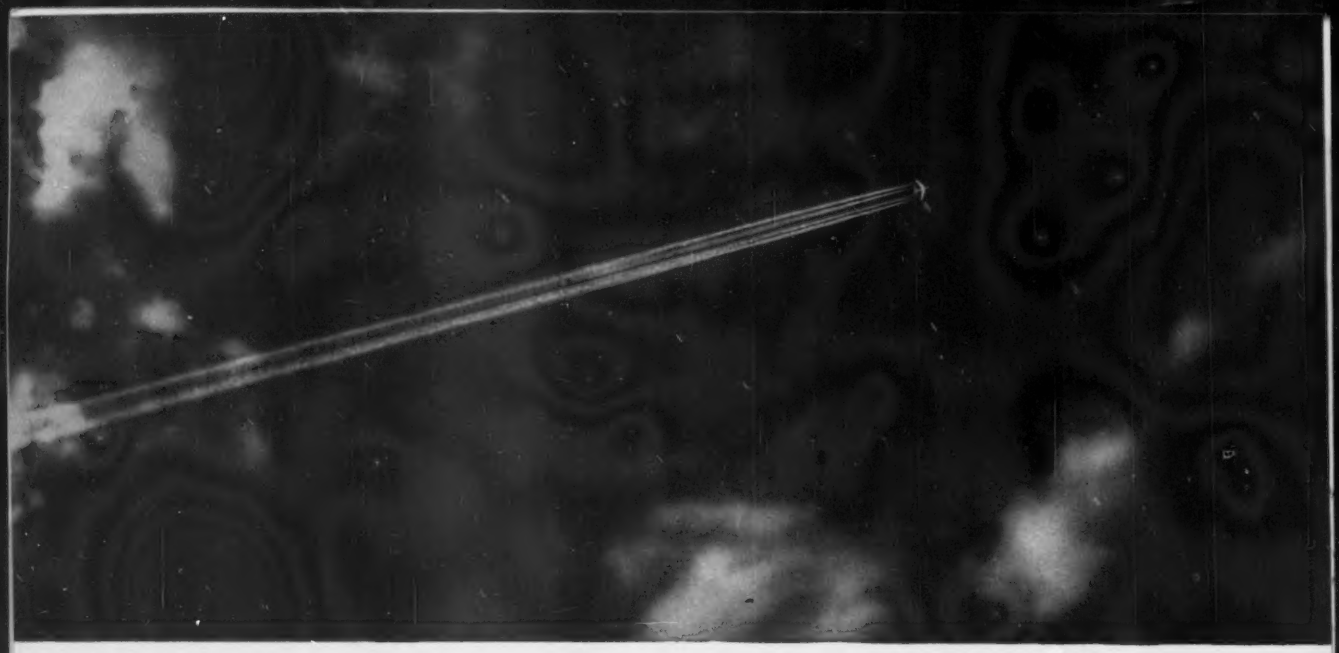

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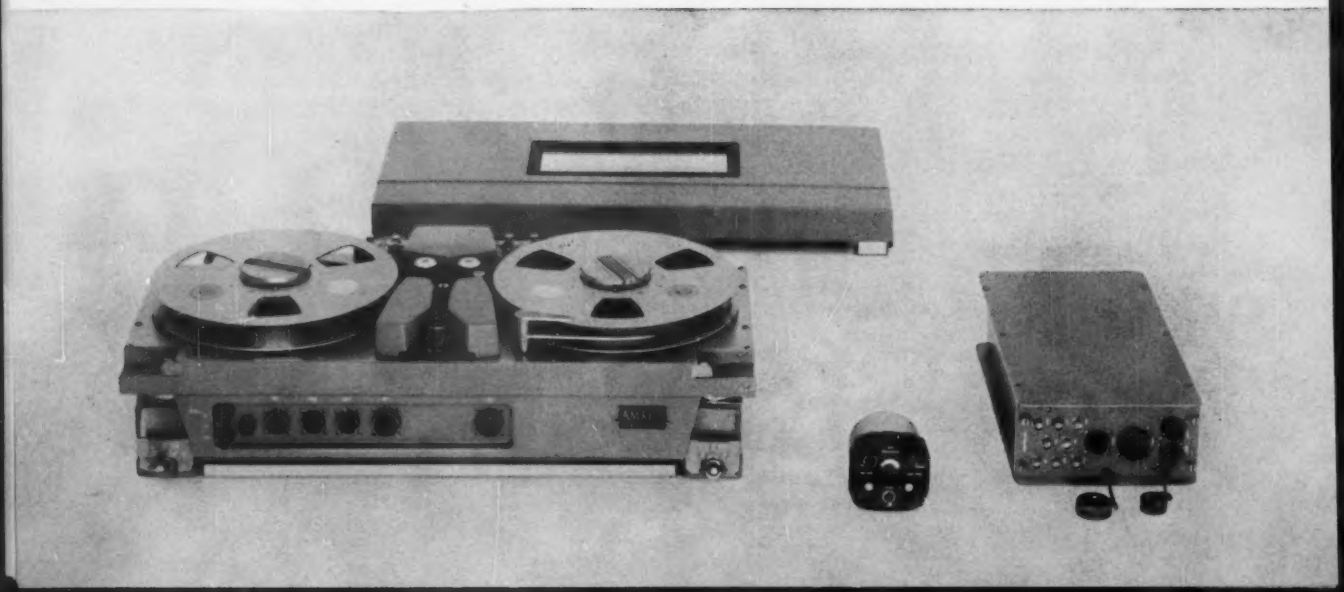

Tracking Weather Satellites

Army's 60-ft dish, being converted for automatic tracking of Tiros weather satellites, uses new lens and waveguide not shown here

FORT MONMOUTH, N. J.—Preparations for tracking the Tiros meteorological satellites (ELECTRONICS, p 11, July 10) are slated for completion here in December.

Operating under the Astro Electronics Div. of the U. S. Army Signal Research and Development Laboratory, the site is situated in the Evans area of USASRDL about 13 miles from Ft. Monmouth.

Two radars will be used: the old 50-ft Diana, which in 1946 was the first radar to bounce a signal off the moon, and a 60-ft parabolic antenna.

Diana is being beefed up for faster scanning but will not be automatic. Capable of carrying out programmed scanning instructions, it will be used for quick looks and other odd jobs.

Being Converted

The 60-ft antenna, originally built by D. S. Kennedy, is being converted to automatic tracking capabilities. Radiation, Inc. is doing the conversion work under a $\frac{1}{4}$-million contract with Army Signal Corps. When completed the dish will be similar in performance to Radiation, Inc.'s TLM-18.

Controlling elements obtain their information through a rotating lens which provides conical scanning. Located at the front of the feed assembly at the waveguide entrance, the lens is constructed with metal disks inserted in Echofoam to delay the wave front on one side of the lens sufficiently to create a scanning half cone angle of $1\frac{1}{2}$ degrees.

The lens is dynamically balanced and rotated at 600 rpm to supply a 10-cps error signal whenever the antenna is off target.

A comparison is made between the 10-cps signal created by scanning the missile and a pair of signals of the same frequency but in quadrature with each other created by a reference generator attached to the lens shaft's rear.

The magnitude and phases of the signal are compared to the two reference signals in the demodulator to produce two independent d-c voltages, one for azimuth control and the other for elevation.

The polarity and magnitudes of these voltages develop torques in the right directions for returning the antenna to the target position. Telemetry band will be 225-265 mc.

Tiros, now a National Aeronautics and Space Administration project, began under the Advanced Research Projects Agency's supervision with a fiscal year 1959 funding of $6,711,000.

Launching in '60

The satellite will be launched from Cape Canaveral, Fla., into a 51 degree angle-of-inclination orbit some time after the first of the year. Though a number of tracking sites will be used, NASA will not reveal locations of them.

Responsibility for the satellite is assigned to the Army Signal Corps. Prime contractor for the payload is RCA. The payload will be 40 in. in diameter and weigh 250 lb. It will have two tv cameras looking out the bottom at the earth, and two sets of radiation detectors.

Information will be recorded remotely and stored on tape. When the satellite comes into view of ground stations, data will be transmitted on command.

Each time the satellite is interrogated it is prescheduled to take more pictures during the next orbit. If the satellite is taking pictures while in view of the antenna, the pictures may be transmitted directly and the magnetic tape sequence bypassed.

If the satellite's transmission misses an antenna, the satellite makes another orbit until it can be interrogated by an antenna station.

Though the first two Tiros satellites will spin, succeeding ones will be stabilized.

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However, an equally important part of our Research and Development Program is concerned with *anticipating* your future timing requirements — and with deveioping in advance the new timing methods and devices that will provide the solutions. In conducting this latter part of our research, we carry out an extensive program at our own complete in-plant laboratory . . . and also take full advantage of the advanced experimental data developed in the laboratories maintained at New York and Chicago by General Time Corporation, our parent organization.

Concerned primarily with "pure" research, the New York laboratory investigates the latest advances in all the basic sciences to determine which have possible application in the field of timing and timing control. The Chicago laboratory concerns itself with applying timing to military and industrial fields. Finally, our own laboratories at Haydon determine how these new timing principles can be applied to the development and manufacture of practical, dependable, economically priced new timing motors and devices that will solve *your* present and anticipated timing problems.

As a result of this triple-team program of research and development, covering every stage from pure science to practical production, you can *always* count on Haydon to provide the latest and finest for your timing needs . . . today, tomorrow and *any* time!

For further information, write now, outlining your timing requirements, or contact your nearest Haydon field engineer.

Haydon
AT TORRINGTON

Division of General Time Corporation

2435 EAST ELM STREET, TORRINGTON, CONNECTICUT

Headquarters for Timing

CONSIDER...

Products shown are twice actual size

Lockheed for electronic ceramics

The research, development and manufacture of miniature electronic ceramic components is centered in the new Electronic Ceramics Laboratory at Lockheed Electronics and Avionics Division (LEAD).

This facility is fully able to provide electronic ceramics to meet your particular specifications: MEMORY CORES, a whole family of square loop cores to suit computer and shift register applications: MULTI-APERTURE DEVICES (MAD), Cavitron equipment for the volume production of any geometry of MAD; RECORDING HEADS, of very dense materials with high flux density ground to a micro-finish; GARNETS, poly-crystalline yttrium-iron garnets with minimum line width and loss tangent; ALUMINA SUBSTRATES, of high mechanical strength, high electrical resistivity and low dielectric loss; CUP CORES, in any size to specified inductance and minimum temperature coefficient; HIGH "Q" MATERIALS, for use as inductors, tuning slugs, transformers—frequency ranges from 1 to 50 megacycles.

What are your requirements? Write ... Marketing Branch, 6201 E. Randolph Street, Los Angeles 22, California. Telephone OVerbrook 5-7070.

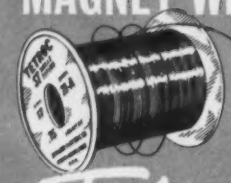
Look to Lockheed for LEADership *in Electronics*

LOCKHEED ELECTRONICS & AVIONICS DIVISION

Requirements exist for staff and supervisory engineers

CIRCLE 53 ON READER SERVICE CARD

TWO OUTSTANDING
HIGH-TEMPERATURE
MAGNET WIRES



Tetroc®
FOR CONTINUOUS OPERATION AT HOTTEST SPOT TEMPERATURES UP TO 200°C

Ceroc®
FOR CONTINUOUS OPERATION AT HOTTEST SPOT TEMPERATURES UP TO 250°C

For continuous operation at hottest spot temperatures up to 200°C (392°F) and up to 250°C (482°F) for short periods of time—depend upon TETROC—an all Teflon-insulated wire available in both single and heavy coatings.

CEROC is Sprague's recommendation for continuous operation at hottest spot temperatures up to 250°C (482°F) and up to 300°C (572°F) for short periods of time. Ceroc has a flexible ceramic base insulation with either single silicone or single or heavy Teflon overlays. The ceramic base stops "cut-through" sometimes found in windings of all-fluorocarbon wire. Both Tetroc and Ceroc magnet wires provide extremely high space factors.

Write for Engineering Bulletins 405 (Tetroc Wires) and 400A (Ceroc Wires).

SPRAGUE ELECTRIC COMPANY
35 Marshall Street, North Adams, Mass.

SPRAGUE®
THE MARK OF RELIABILITY

Navy Expands Air

Adds hardware such as scan converter, plans to increase radar traffic centers from 6 to 17

Televised markers (known as shrimp boats) identify radar blips as incoming planes in new scan-conversion system for air traffic control

OCEANA, VA.—LAST MONTH the U. S. Navy again declared itself very much in the radar air traffic control business, and in to stay insofar as Navy is concerned.

Positive radar air traffic control is widely accepted as one key to a nationwide airways system fully capable of coping with the problems of the jet age.

Handled Individually

Positive radar air traffic control means that each aircraft within a given airspace is individually handled by a radar controller. Radar traffic control has three stages: medium-range radar surveillance out to 200 mi, airport or short-range surveillance radar (ASR) out to 50 mi, and precision approach radar (PAR). The last two stages form what is commonly thought of as radar ground-controlled approach (GCA).

Right now four groups, Air Force, Navy, Army and Federal Aviation Agency, have some stake in radar air traffic control. The FAA, however, has primary responsibility for air traffic control within continental U. S.

The Air Force is working towards integration of its some three dozen RAPCON (Radar Approach Control) centers with similar units run by FAA. This process will result in an integrated network of some 70 centers. Timetable allows some five years. There have also been suggestions that the Sage system could fit into the overall air traffic control picture.

Navy, however, plans to expand its present network of six radar air traffic control centers (RATCC) to 17, and operate them largely on its own. Navy sees its air traffic control job as including carrier controlled approach (CCA) and is re-

Control

training carrier groups ashore for CCA; operating PAR units at naval air facilities; operating Marine air traffic units (MATU) and control of Project Barrier, the radar picket planes operating off the east and west coasts.

New Hardware

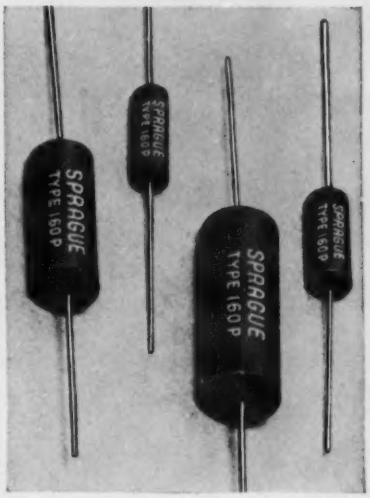
Recently, Navy supplemented its 200-mi medium-range radar here with the so-called Spanrad system (Superimposed PANoramic RAdar Display) made by Intercontinental Electronics Corp. of Mineola, N. Y. The equipment was developed by CSF (Compagnie General de Telegraphie sans Fils) of Paris, 40-percent owner of Intec.

Spanrad is a scan converter that changes the plan-position-indicator radar display to television video and displays it on studio-type monitors around the air traffic control room. Heart of the unit is the video transformation tube, a two-gun cathode-ray storage tube. Circuits on the input side of the tube make up a radar ppi. Circuits on the output side are essentially tv studio-type video equipment. The television signal uses 625 lines at 60 frames (twice usual frame rate). Its bandwidth is 7 mc.

Scans Plotting Board

The system also includes a tv camera tube that scans a translucent plotting board. Here a controller can trace out flight paths and indicate points with grease pencil and identify blips by markers known as shrimp boats. Conversion of radar video to tv video results in a brighter display while the longer persistence phosphor of the tv monitors effectively puts an identifying tail on each moving target. The Oceana Spanrad installation consists of 2 scan converters (138 tubes each), 11 tv monitors and 2 tv cameras. The system came to about $100,000, the scan converters: about $28,000 each. Navy says Spanrad has increased all-weather aircraft recovery potential here from 24 per hour to 60 per hour by permitting each controller to keep track of more planes.

New Molded Dual-Dielectric Capacitors Defy Heat and Humidity

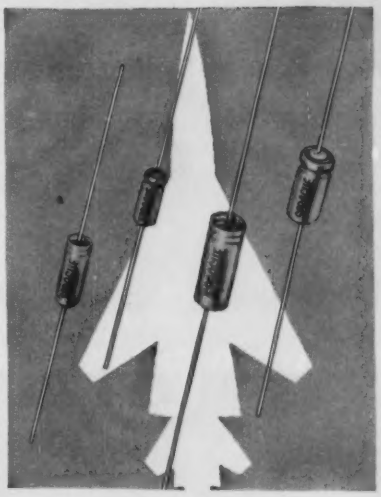


A new line of molded tubular capacitors for entertainment and commercial electronics that can survive the high temperature and humidity of tropical and sub-tropical climates has just been announced by the Sprague Electric Company. Called DIFILM® Black Beauty® Capacitors, these high performance components have a new dual paper-film dielectric and solid impregnant combination which gives both the proven long life of paper capacitors and the effective moisture protection of plastic film capacitors. Units are small in size and low in cost.

These DIFILM Capacitors offer the circuit designer many important characteristics: very high insulation resistance, low power factor, moderate capacitance change with temperature, excellent retrace under temperature cycling, and superior long-term capacitance stability. Maximum operating temperature is 105 C without voltage derating.

For complete specifications on DIFILM Black Beauty Capacitors, write for Bulletin 2025 to Technical Literature Section, Sprague Electric Co., 35 Marshall Street, North Adams, Massachusetts.

CIRCLE 230 ON READER SERVICE CARD



NEW WET-ANODE TANTALEX® CAPACITORS

for 125 C operation

Another Sprague "first" for military and industrial designers—Type 130D Wet-Electrolyte Tubular Sintered-Anode Tantalex Capacitors for 125 C operation without voltage derating.

The remarkable electrical stability of these capacitors is the result of *special aging*, the use of *inert materials*, and a *low diffusion seal*. Construction is designed to meet the 2000-cycle military missile vibration requirement. Shelf life is excellent.

Shoulder-less shape makes mounting on printed wiring boards easier, avoids punching slots in boards or the use of "chairs", and simplifies board wiring layout.

For complete technical data, write for Bulletin 3701 to Technical Literature Section, Sprague Electric Co., 35 Marshall St., North Adams, Massachusetts.

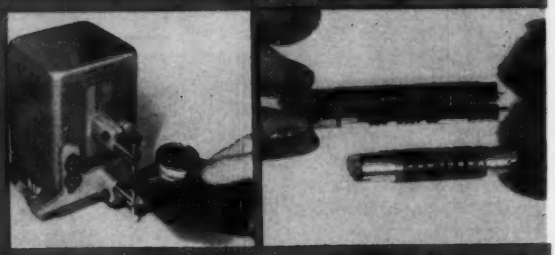
SPRAGUE®
THE MARK OF RELIABILITY

CIRCLE 55 ON READER SERVICE CARD

HOW TO PRODUCE 33 UNIFORM MINIATURE WELDS OF 4 DIFFERENT METALS

COLLINS RADIO ACHIEVES PRODUCTION GOALS WITH WELDMATIC WELDING

A new, exceptionally reliable mechanical filter — key component in the Collins version of the highly strategic Single Sideband Radio — is now in production using an all-welded construction provided by Weldmatic equipment. This advanced filter makes possible improved selectivity characteristics and better utilization of the radio spectrum. Unvarying uniformity of the weld nugget and absolutely no displacement of the positioned parts are required specifications. Electrical characteristics are extremely critical . . . each of 33 connections must be identical in production quantities! After extensive evaluation, Collins selected Weldmatic's 1032 Miniature Welding Head and Model 1026 Power Supply . . . the combination that has enabled Collins to meet its production goals. They're a real team for precision welding: the miniature head with perfect vertical electrode motion and accurate repeatable pressure — the power supply with ultra-short current flow (0.001 second) over a continuously variable heat range. Why not consider Weldmatic for your metal-joining problems? WRITE for our free 20-page brochure describing techniques, applications, and Weldmatic's sample welding service.



(Left) Pressure gage, which is used for calibrated from 0 to 50 lbs., insures exact weld pressures from job to job. (Right) Welded filter cartridge and completed miniaturized Collins filter.

WELDMATIC

370 NORTH HALSTEAD AVENUE, PASADENA, CALIFORNIA — DIVISION OF UNITEK CORPORATION

the "Do-it-yourself" transformer

FLEXIFORMER

packaged transformer primary

- **a multiple source of a-c voltages**
- **a current transformer**

Here is the original "do-it-yourself" transformer . . . the FLEXIFORMER packaged transformer primary. It is a portable, self-contained toroidal primary coil molded in durable high-impact plastic. The SUPERIOR 5-WAY binding posts provided for connections are colored for relative polarity identification. The primary consists of a strip-wound silicon steel core having a coil of 400 turns of copper wire.

when used as a source of a-c voltage

the center opening permits hand threading the proper number of secondary winding turns to obtain the desired output voltage. Input rating is 120 volts, 50/60 cycles, 1 phase and output rating is 150 VA.

when used as a current transformer

the FLEXIFORMER winding becomes the secondary winding with the current induced by a wire passing through the center opening. Primary rating of 400 amperes and secondary rating of 1.0 ampere. Accuracy is 1% at 60 cycles.

THE SUPERIOR ELECTRIC COMPANY

BRISTOL, CONNECTICUT, U.S.A.

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So easy to use...
no more searching for the right transformer

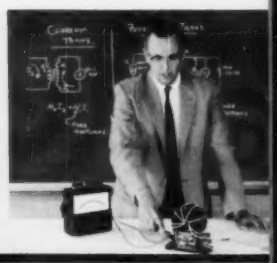
FLEXIFORMER

packaged transformer primary

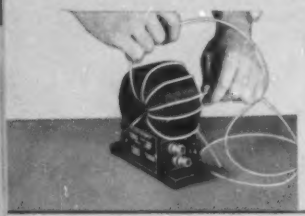
lets you wind your own!

Versatile laboratory and shop apparatus. Especially useful when high amperage at low voltage is required. Can be used for testing the current carrying capacity of components. Eliminate the task of obtaining the right transformer for each new job.

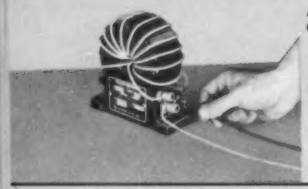
Valuable classroom and home workshop aids. Can be used to demonstrate basic transformer principles and also serve as working laboratory equipment. The time-and cost-saving "do-it-yourself" feature is a principal advantage of FLEXIFORMERS.



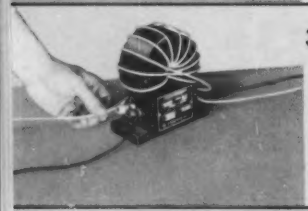
...as a source of a-c voltages



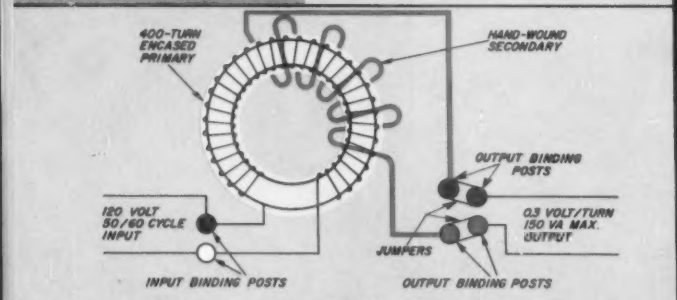
1 With 120 volts primary input, each turn added to the secondary supplies 0.3 volt output. Thread the correct number of turns through the center hole.



2 Connect the ends of the secondary wire to the upper set of red and green binding posts. Connect the load to the lower set of binding posts.



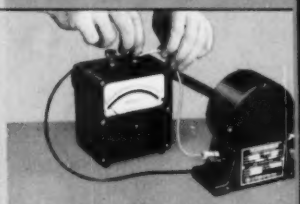
3 Connect the input to the black and white binding posts. For infinite output voltage adjustment, a POWERSTAT variable transformer may be used in the input.



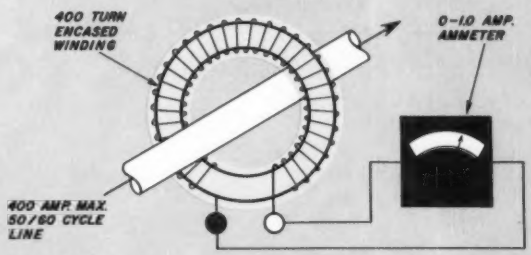
...as a current transformer

1 Pass the current carrying conductor through the FLEXIFORMER opening the required number of times.

2 Connect a 0-1 ampere ammeter to the black and white binding posts and energize the current carrying conductor.



3 Consult the chart to obtain the proper multiplier needed to calculate the current from the reading obtained.



THE SUPERIOR ELECTRIC COMPANY, Bristol, Connecticut

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name

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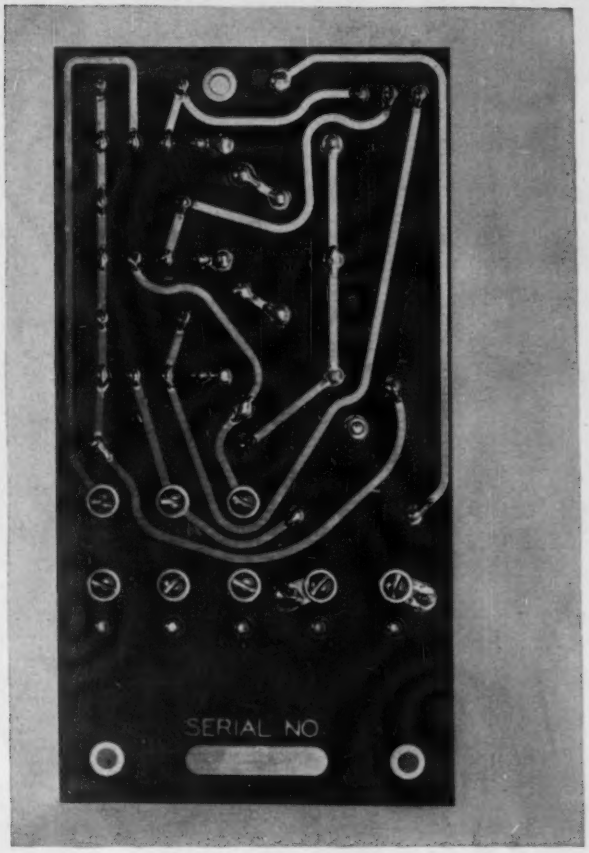
Request FLEXIFORMER Bulletin giving full technical information, ratings and specifications.

THE SUPERIOR ELECTRIC COMPANY

Bristol, Connecticut

SE-L8599



High strength-to-weight ratio. This printed wiring board for a phase failure relay (manufactured by Phase-Guard Co., Carnegie, Pa., and distributed by Stradley Engineering Co., Pittsburgh) was designed with CDF Di-Clad 28E (epoxy resin laminated with medium weave glass cloth) for high mechanical strength, very low moisture-absorption, and good insulation resistance. Details upon request.

How CDF Di-Clad* can solve your printed-circuit problems

The CDF line of copper-clad laminates in all grades is now known by a new name—Di-Clad. Di-Clad grades meet the varying needs of design, production, and operation of electronic equipment. Grades other than those described are also available.

Di-Clad 2350. An economy paper-base phenolic grade having good tensile, flexural, compressive, and impact strength. Adequate for most non-critical printed circuit applications. Can be cold punched and sheared up to 5/64 of an inch in thickness.

Di-Clad 112T. A Teflon* glass-fabric laminate offering the best dielectric properties over a wide temperature and frequency range.

Send us your requirements and let our engineers help you select the right grade for your application.

*Du Pont trademark for its tetrafluoroethylene resin.

CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE Budd COMPANY • NEWARK 16, DEL.

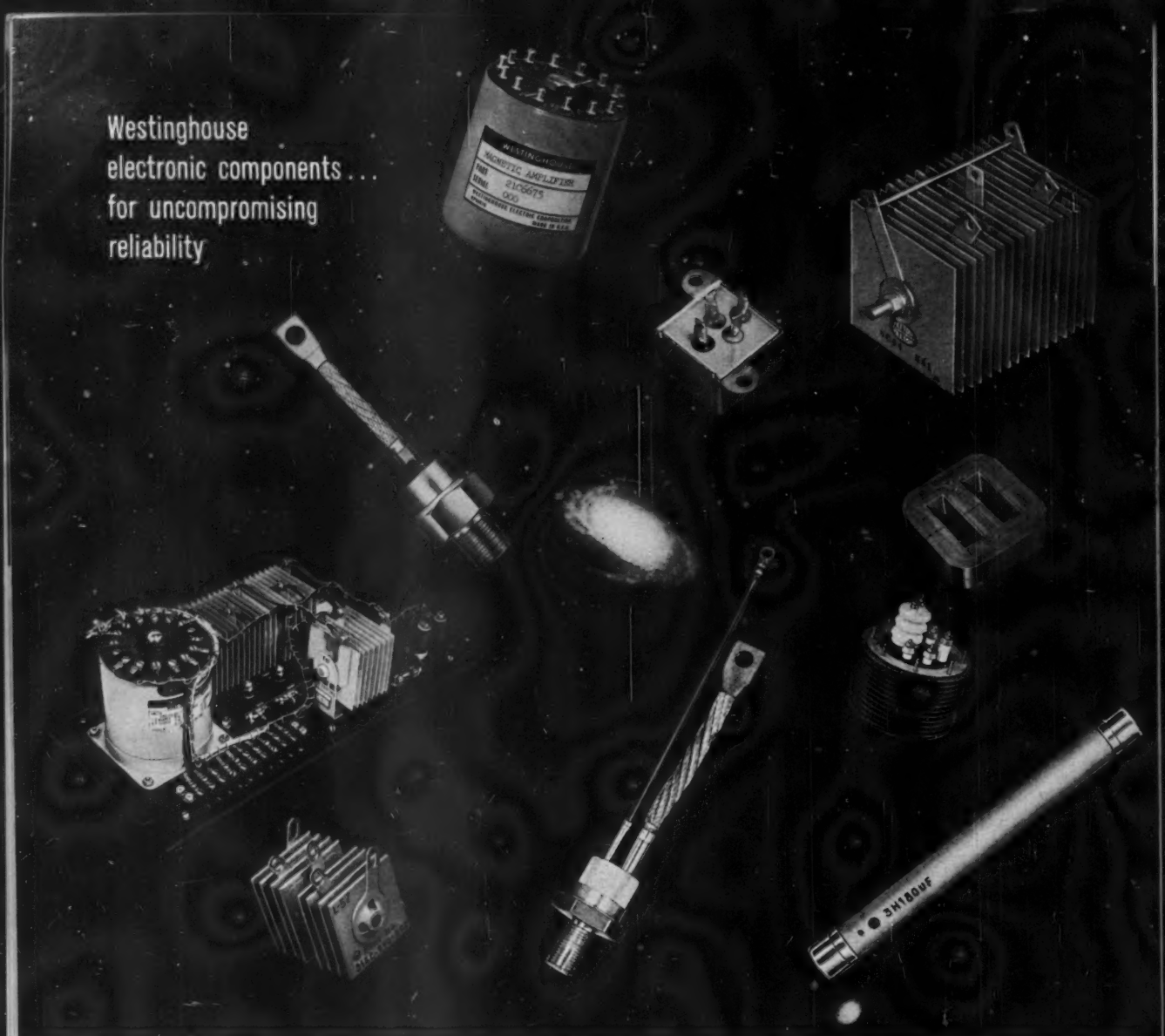
In Canada: 46 Hollinger Road, Toronto 16, Ont.

TYPICAL Di-Clad PROPERTY VALUES

	Di-Clad 2350	Di-Clad 26 (NEMA XXXP)	Di-Clad 28 (NEMA XXXP)	Di-Clad 28E (NEMA G-10)	Di-Clad 112T Teflon*
BOND STRENGTH—0.0014" foil (lbs. reqd. to separate 1" width of foil from laminate)	6 to 10	6 to 10	6 to 10	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (Deg. C.)	120	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil for 1/16" thickness)	800	900	850	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90% RH (ASTM D257, Fig. 3)	500	150,000	600,000	100,000	75,000
DIELECTRIC CONSTANT 10^6 Cycles	4.5	4.0	3.6	4.9	2.6
DISSIPATION FACTOR 10^6 Cycles	0.040	0.026	0.027	0.019	0.0015
ARC-RESISTANCE (Seconds)	5	10	10	130	180
TENSILE STRENGTH (psi.)	18,000	16,000	12,000	48,000	23,000
FLEXURAL STRENGTH (psi.)	27,000	21,000	18,000	70,000	13,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.80	0.45	0.42	12.0	6.0
COMPRESSIVE STRENGTH flatwise (psi.)	32,000	28,000	25,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Paper	Paper	Paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural	Natural greenish	Natural	Natural	Natural

All these standard grades are available with 0.0014" and 0.0028" or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*Du Pont Trademark



Airborne components that guarantee circuit reliability

In the airborne electronics field—plane, missile or space program—the paramount requirements are: reliability, durability, light weight and small size. Westinghouse combines these product characteristics with engineering talent and breadth of line to offer you an exceptional source for a greater variety of electronic components and subassemblies than any other manufacturer.

Weapons systems like THOR, TITAN, FALCON, TARTAR, BOMARC, and many still classified have specified "Westinghouse" for this reason.

However demanding your requirements may be, your best insurance to protect your circuit designs is the Westinghouse line of high-reliability components. For assistance call your Westinghouse sales engineer or write: Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pa.

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WESTINGHOUSE ELECTRONIC COMPONENTS
for projects that must not fail

Control Devices • Instrumentation • Laminated Plastic Forms (Micarta®) • Magnetic Amplifiers • Magnetic Materials • Power Supplies • Static Inverters • Semiconductors • Transformers and Components • Tubes: Cathode-Receiving-Power-Nuclear Control

Write for your copy of the new Westinghouse Electronic Components Design Engineers Handbook.

J-92027

YOU CAN BE SURE...IF IT'S

Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV FRIDAYS

Console (center) lets guard communicate with nine points, while subsystem panels (left and right) give him security information

Electronics Guards Plants

New integrated system has central controls, uses both conventional and novel detectors

INTEGRATED PLANT PROTECTION system was unveiled late last month in New York by Minneapolis-Honeywell.

M-H's electronic watchdog system uses some conventional detection devices, some new ones. All detectors are tied together into a master control panel from which a single guard can maintain control over an entire building or factory—even one covering acres.

M-H has installed one system in its own Brown Instruments division in Philadelphia (cut), is putting a second into the Chicago Art Institute. The Philadelphia installation cost $33,769, with net savings in the first year expected to total $26,270. Chicago Art Institute installation is expected to pay for itself in 36 months.

A wide variety of intrusion and detection devices can be used with the system. Included are conventional fire-detector heads working on both fixed temperature and rate of rise; smoke sensors; magnetic switches and detection tape for windows; pressure-sensitive mats; holdup alarm switches.

Closed-circuit tv, together with remote-controlled magnetic switches on gates and doors, allow the guard to maintain surveillance on entrances and exits. Lens adjustments on the cameras can be made from the control console. Intercom systems tie in to the control center to permit communication and identification.

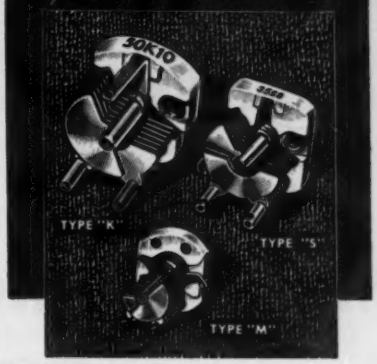
Speakers mounted in rooms remote from the control console can be rigged to detect above-normal noise, automatically set off audio or visual alarms.

Two new motion detectors use light and sound patterns respectively. The Vitronic eye is used in lighted areas indoors or outdoors. Disturbance in the light pattern between transmitter and amplifier (which may be 2,000 ft apart) generates an alarm signal which alerts the guard. The Sono-Sentry sends an audible signal into a closed area, and the resulting pattern is recognized by a sensitive receiver. Any motion in the area that disturbs the signal pattern triggers an identifying buzzer and alarm on the master control panel.

The system uses a two-wire network to link the detectors and effectors to the control center. If audio functions (intercoms, for instance) are included, the network is effective up to about 3 miles; if only alarm functions are included, it can carry signals up to 20 miles.

JOHNSON MINIATURE CAPACITORS

Compact Design! Rugged Construction!



Save valuable space in RF equipment...

Johnson miniature and sub-miniature air variable capacitors are available in a wide range of sizes, types, and capacities—perfect for use in compact RF applications. The 3 types described below have soldered plate construction, oversize bearing, and heavily anchored stator supports to provide extreme rigidity. Inductance path to both stator supports is extremely low with bridge-type stator terminal. Large compression rotor contact provides steady torque—rotor stays "put" where set. Rotor contact and all other metal parts are nickel-plated—steatite insulator is DC-200 treated.

SUB-MINIATURES—In addition to the miniature air variables described below, the new Johnson Type "T" and "U" sub-miniature capacitors are also available in production quantities. Write for our new components catalog 978 listing complete specifications.

TYPE "M"—Peak voltage 1250 volts on .017" plate spacing; 850 volts on .013" spaced units. Shaft slotted for fast screwdriver adjustment—mounting bushing threaded with flats to prevent turning—mounting nut furnished. Available in production quantities with the following features: locking bearings; 180° stop; various shaft extensions; high torque; silver or other platings. Single section, butterfly, and differential types available.

TYPE "S"—Midway in physical size between the Type "M" and "K" capacitors, the Type "S" has a plate spacing of .013" with a peak voltage rating of 850 volts. Other spacings, single hole mounting types, straight shaft, screwdriver shaft, or locking type screwdriver shaft available on special order in production quantities.

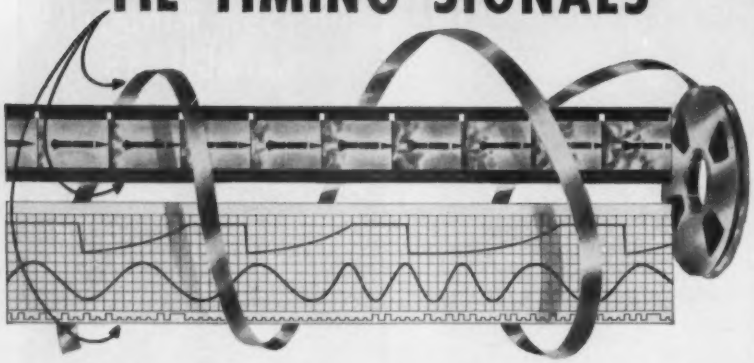
TYPE "K"—Widely used for many military and commercial applications, the Type "K" has a peak voltage rating of 1000 volts with a plate spacing of .015". Unit is available in production quantities to meet MIL-C-92A specifications—other capacities and variations for specialized military and commercial applications are also available in production quantities.

New Catalog

For detailed specifications, including engineering drawings, on Johnson miniature and sub-miniature capacitors, as well as other Johnson electronic components, write for your free copy of our new components catalog No. 978.

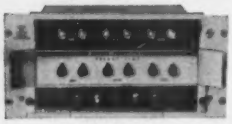
E. F. JOHNSON CO.
1820 Second Avenue S.W. • Waseca, Minn.

TIE TIMING SIGNALS

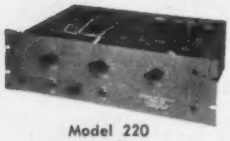


to different recording media with

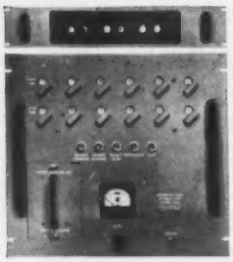
HERMES TIMING EQUIPMENT



Model 270
DIGITAL
TIMING GENERATOR



Model 220
RETARDED
BIT RATE UNIT



Model 202
MAGNETIC
TAPE SEARCH UNIT

Hermes Timing Equipment is specifically designed to correlate precise timing signals with data on different recording media such as recording cameras, plotting boards, strip charts and high or low speed oscillographs. This timing equipment consists of a Digital Timing Generator and Retarded Bit Rate Unit which operate during periods of data acquisition and a Magnetic Tape Search Unit which operates during periods of data reduction.

Digital Timing Generator, Model 270, is an all solid-state instrument which generates binary coded decimal signals as recorded on magnetic tape providing a precise digital index in terms of elapsed time. The Generator also visually displays the exact time in hours, minutes, and seconds as illuminated digits. An Airborne Digital Timing Generator, Model 206A, which meets all the essential requirements of MIL-E 5400 is also available.

Retarded Bit Rate Unit, Model 220, operates in conjunction with Timing Generators, Models 270 or 206A, to provide a pulse-height, pulse-width signal, for recording time on equipments other than magnetic tape recorders.

Magnetic Tape Search Unit, Model 202, is used to control a magnetic tape transport during periods of data reduction for automatically searching the tape on the basis of time indices previously recorded by any one of the two Timing Generators. The Retarded Bit Rate Unit, Model 220, can also be used with Model 202 for reproducing time on oscillographs as previously recorded on the tape.

Auxiliary equipment including a Run Code Selector, Model 225, for inserting data run code numbers and a Tape Input Programmer, Model 230, for automatically programming tape search are also available.

Write for Technical Bulletins on Hermes Timing Equipment.

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MEETINGS AHEAD

Nov. 16-20: Magnetism & Magnetic Materials, AIEE, AIM, APS, IRE, ONR, Sheraton-Cadillac Hotel, Detroit.

Nov. 17-19: Northeast Electronics Research and Engineering Meeting, NEREM, Annual, Commonwealth Armory, Boston.

Nov. 23-24: Solid Facts About Solid State, Symposium, ISA, IRE, Ben Franklin Hotel, Philadelphia.

Dec. 1-2: Circuit Theory, Mid-West Symposium, PGCT of IRE, Brooks Memorial Union, Marquette Univ., Milwaukee.

Dec. 1-3: Eastern Joint Computer Conference, AIEE, ACM, PGEC of IRE, Hotel Statler, Boston.

Dec. 3-4: Vehicular Communications, Annual Meeting, PGEC of IRE, Colonial Inn & Desert Ranch, St. Petersburg, Fla.

Dec. 8-10: Electrical Insulation, Applications, Nat. Conf., AIEE, NEMA, Shoreham Hotel, Cleveland.

Jan. 11-13: Reliability & Quality Control, National Symposium, ASQC, IRE, EIA, AIEE, Statler Hotel, Washington, D. C.

Jan. 25-27: Plant Maintenance and Engineering Conf., Philadelphia.

Jan. 31-Feb. 5: Comparison of Control Computers, Winter General Meeting, AIEE, New York City.

Feb. 3-5: Military Electronics, Winter Convention, Biltmore Hotel, Los Angeles.

Feb. 10-12: Solid-State Circuits Conf., AIEE, PGCT of IRE, Univ. of Penn., Philadelphia.

Feb. 11-13: Electronic Representatives Assoc., Annual Convention, Drake Hotel, Chicago.

Feb. 20-29: Component Parts and Electronic Tubes, International Exhibition, Porte de Versailles, Place Balard, Paris.

Mar. 21-24: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, N. Y. C.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 104.

These R&D Projects for Future Decades in Space

typify Lockheed's vast program of Air/Space Science

■ New programs under development at Lockheed's California Division are planned to solve America's future exploration projects into space. The new multimillion-dollar Research Center in nearby San Gabriel mountains is further evidence of Lockheed's determination to support and supplement its already extensive research and development activities.

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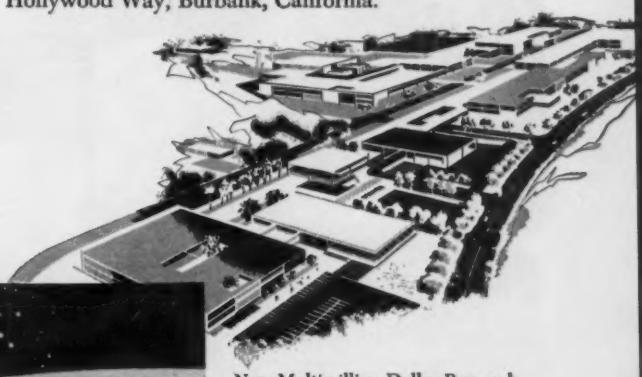
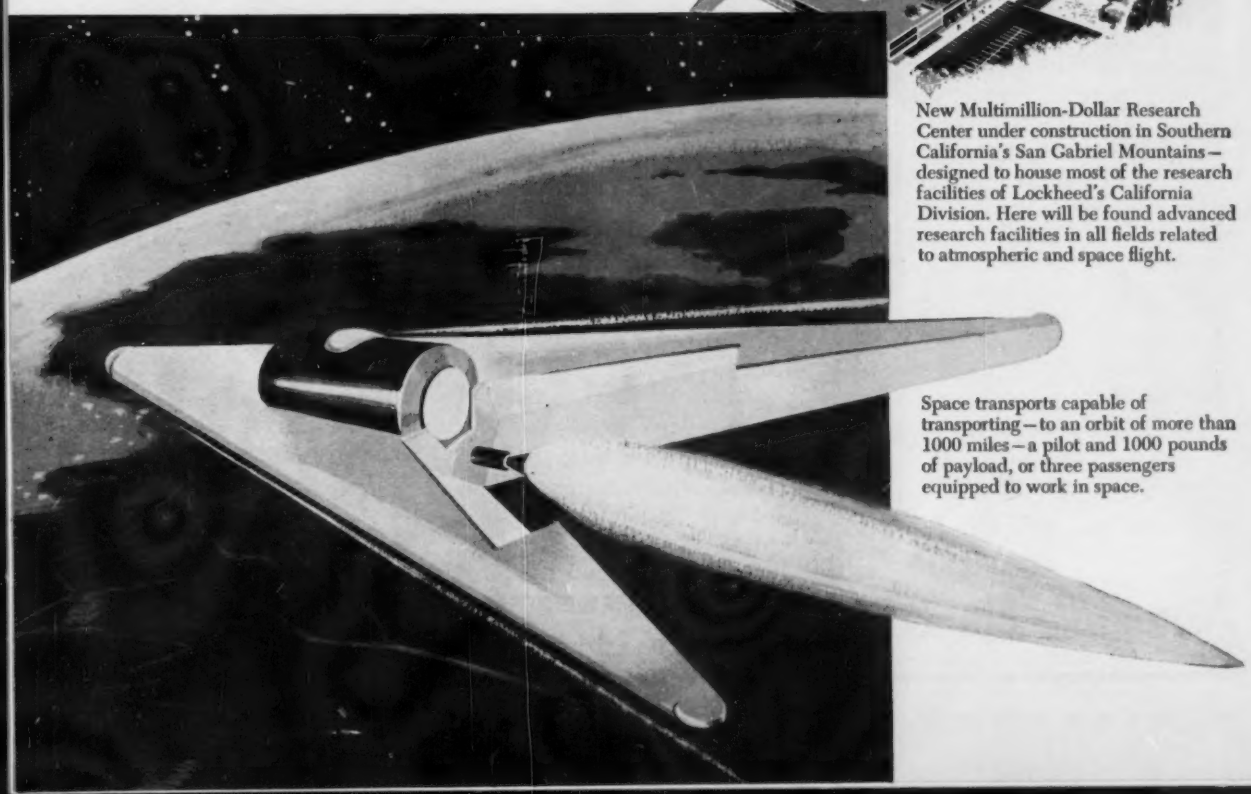


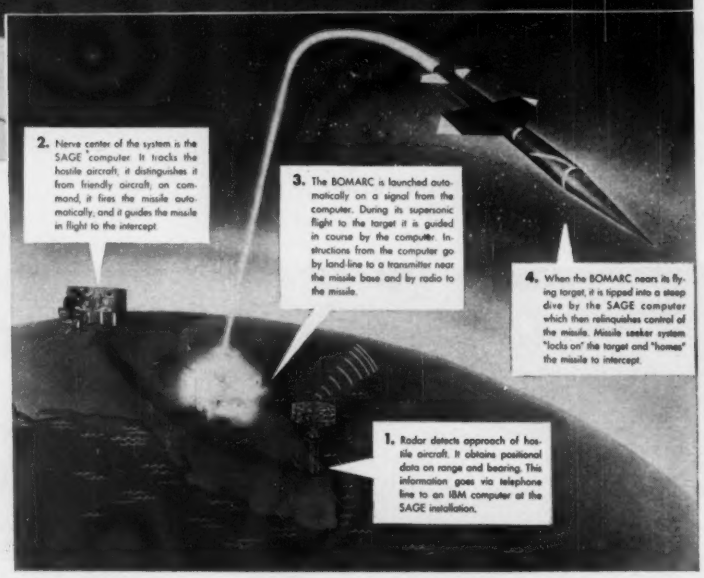
New Multimillion-Dollar Research Center under construction in Southern California's San Gabriel Mountains—designed to house most of the research facilities of Lockheed's California Division. Here will be found advanced research facilities in all fields related to atmospheric and space flight.

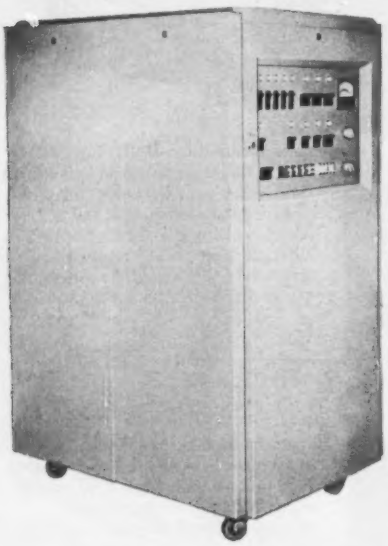


Space transports capable of transporting—to an orbit of more than 1000 miles—a pilot and 1000 pounds of payload, or three passengers equipped to work in space.

This Power Supply Provides Dependable Performance to the Magnetic Tape Units of the IBM SAGE COMPUTER

Computer Operating and Programming Room at one of the U. S. Air Force's SAGE Installations


2. Nerve center of the system is the SAGE computer. It tracks the hostile aircraft, it distinguishes it from friendly aircraft, on command, it fires the missile automatically, and it guides the missile in flight to the intercept.
3. The BOMARC is launched automatically on a signal from the computer. During its supersonic flight to the target it is guided in course by the computer. Instructions from the computer go by land-line to a transmitter near the missile base and by radio to the missile.
4. When the BOMARC nears its flying target, it is tipped into a steep dive by the SAGE computer which then relinquishes control of the missile. Missile seeker system "locks on" the target and "homes" the missile to intercept.
1. Radar detects approach of hostile aircraft. It obtains positional data on range and bearing. This information goes via telephone line to an IBM computer at the SAGE installation.



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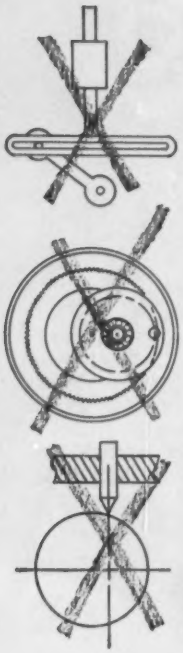
How to keep computers compact



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Weight	2 oz. max.
Mechanical Rotation	Continuous
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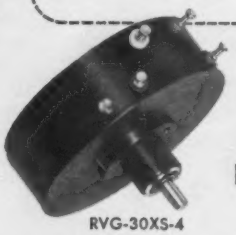

RVG-30XS-4

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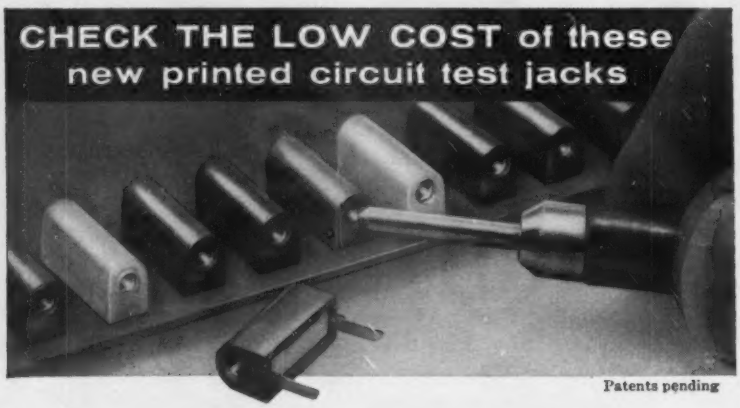
PRECISION POTENTIOMETERS

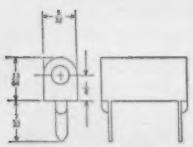
INTEGRALS OF HIGH PERFORMANCE

CIRCLE 203 ON READER SERVICE CARD

CHECK THE LOW COST of these new printed circuit test jacks



Patents pending



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Samples on request

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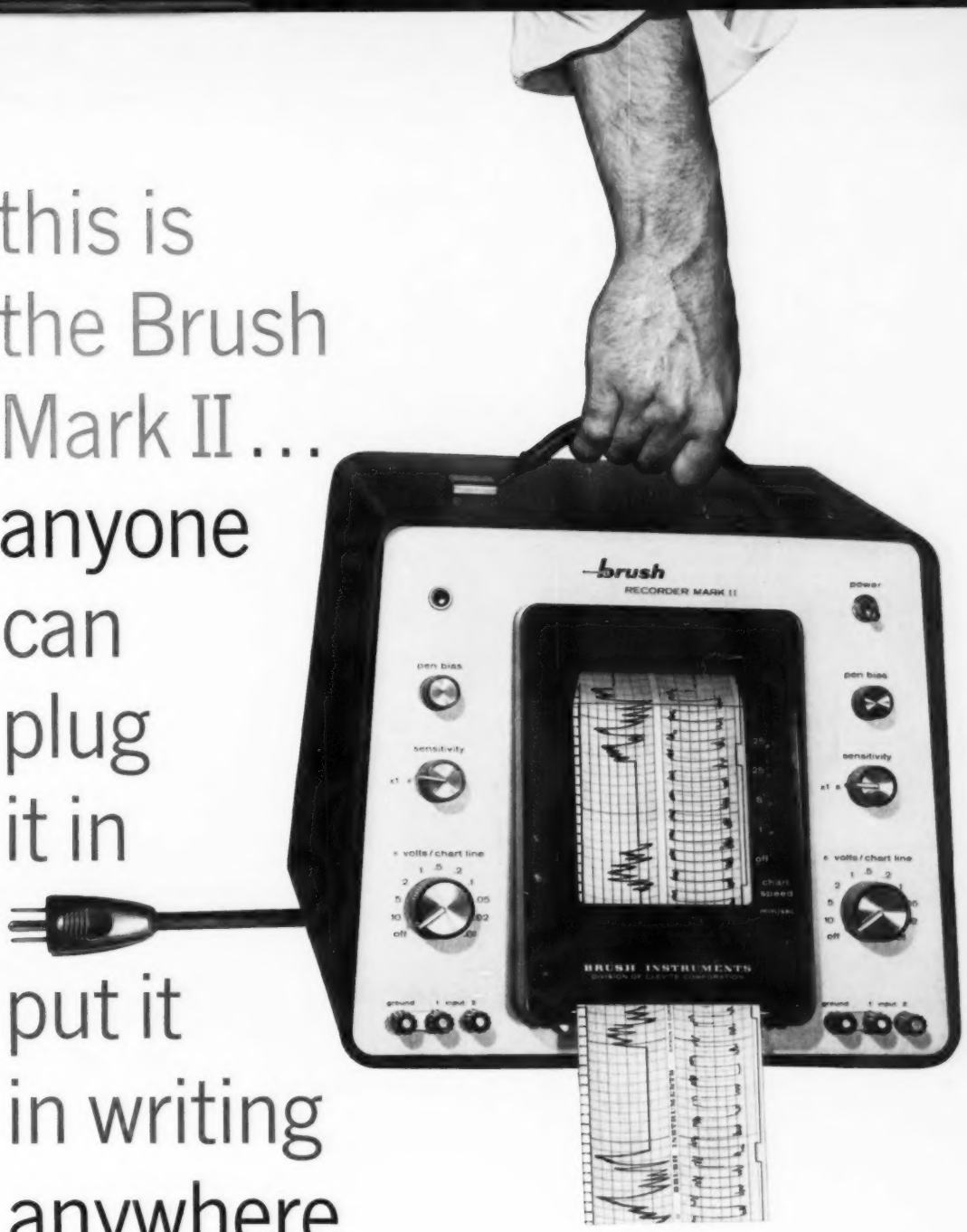
CIRCLE 67 ON READER SERVICE CARD→

this is the Brush Mark II... anyone can plug it in put it in writing anywhere



There is no direct writing recorder on the market that approaches the compact Mark II in sheer usefulness. It is a completely integrated engineering tool that can be operated by anyone . . . in the shop or in the field . . . for countless research or design requirements. Every function necessary for uniform, crisp, easily reproduced readouts is "built-in". The Mark II gives you two analog channels plus two event markers; 4 chart speeds; DC to 100 cps response with 40 mm amplitude; 10 mv/mm sensitivity; high input impedance. Immediate shipment from stock. Call, write or wire for complete details.

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for direct writing recording systems no one is as qualified as Brush

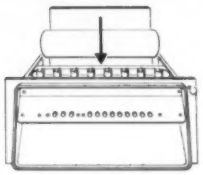
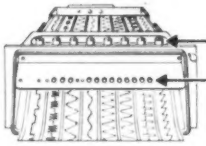
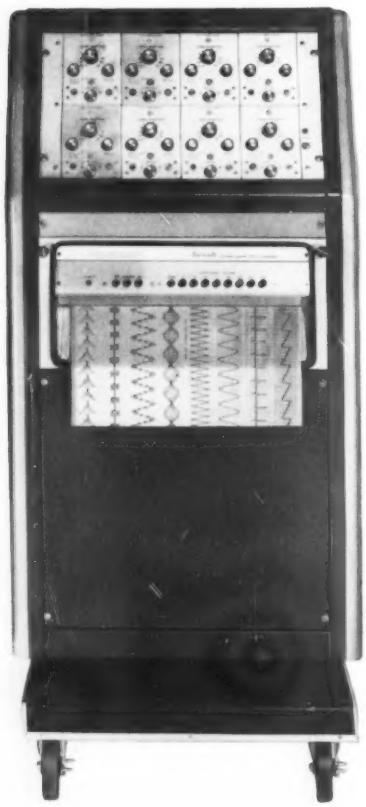


Chart paper loads from top



Trace contrast control

Simple pushbutton speed selection



Why? Simply because Brush recording systems such as this 6-8 channel unit incorporate all of the known refinements in the art of recording by direct writing. No comparable system in existence today is as compact . . . as simplified . . . as reliable . . . as versatile. Note slide-mounted oscillograph and interchangeable "plug-in" signal conditioners that provide four vital functions in addition to amplification: high input impedance, zero suppression, attenuation and calibration.

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37TH AND PERKINS CLEVELAND 14, OHIO

electronics
NOVEMBER 13, 1959

Operating portion of prototype isotope-heated, vacuum-diode thermionic converter (under bell jar) being tested using filament heat source and shield to prevent heat loss

Thermoelectron Engines: Future Power Sources?

Promise of high efficiency, lightness and maintenance-free operation makes thermionic generation of electricity commercially attractive. Here are techniques and devices currently under development

By GEORGE N. HATSOPOULOS, Associate Professor,
and JOHN WELSH, Assistant Professor, Mechanical Engineering Dept., Massachusetts Institute of Technology;
and EDWIN LANGBERG, Director of Research, Thermo Electron Engineering Corp., Cambridge, Mass.

RESEARCHERS of the past decade have focused heavy attention on techniques for directly converting heat into electricity without the use of moving mechanical parts. It now appears that practical devices of this type will be available in the next few years for a variety of applications ranging from space vehicles to household appliances.

TECHNIQUES STUDIED—Both thermoelectric and thermionic conversion devices have been studied. The thermoelectric technique utilizes the Seebeck effect, commonly known as the thermocouple effect, discovered by Seebeck in 1821. Prototype thermoelectric generators have recently been developed by several firms. One of the most interesting of these is the 3-watt unit developed by the Minnesota Mining and Manufacturing Co. and The Martin Co. for the Atomic Energy Commission's Snap III program. Its

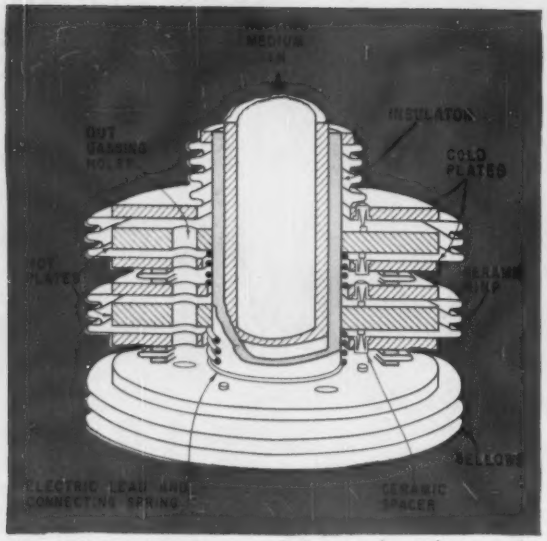

FIG. 1—Construction of vacuum-diode type thermoelecton engine

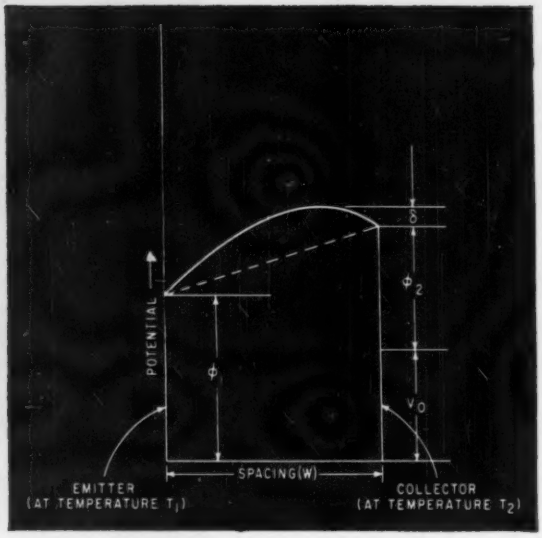

FIG. 2—Potential distribution in vacuum-diode

efficiency is reported to be 6½ percent.

The thermionic technique makes use of the flow of current from the surface of hot bodies when enclosed in a vacuum as described in a patent by Thomas Edison in 1883. Although this effect has been thoroughly studied by scientists, only recently has it been seriously proposed for the conversion of heat into electricity. The first systematic work in this direction was initiated in the Mechanical Engineering Department at the Massachusetts Institute of Technology in 1953. Since then, a large group of scientists at M.I.T. and in the research laboratories of General Electric Company, Radio Corporation of America, Los Alamos and the Thermo Electron Engineering Corporation have been engaged in research and development in thermionic conversion.

Early prototypes are likely to produce relatively small amounts of electric power in the range from 1/10 watt to 5 kilowatts; however, ultimate power levels attainable are no more limited than power levels attained by large steam power generating stations. Nuclear reactor technology of the future may also benefit from these developments. Reactors using thermionic conversion will not require circulating fluids and heat exchangers associated with turbines, thus should be more efficient, compact and economical.

THERMOELECTRON ENGINES—The basic feature of the thermionic converter is that it partially converts kinetic energy of emitted electrons into useful electrical energy which can be dissipated in an external load. There is a similarity between the thermionic converter and the steam engine. In the steam engine, water vapor works against a piston or turbine blade; in the thermionic converter, electrons are evaporated from an emitter surface and do work against a retarding electric field. Thus, these converters can be thought of as thermoelectron engines.

Thermoelectron engines are technologically similar to vacuum tubes. Also, they are comparable in size, weight, and ruggedness to tubes having the same power handling capacity. Since thermoelectron engines contain no moving parts, they are likely to be especially useful in remote applications where freedom from maintenance will give them a distinct advantage over conventional generating devices.

A typical termoelectron engine based on a vacuum-diode element is shown in Fig. 1. Heat penetrates through a thin insulating tube into hot-plate emitter fins. These emitter fins are covered on both sides by cold plate collector cells. The cells can be connected in series to provide a higher voltage and a more practical impedance level for most applications. This design may produce up to 5,000 watts/ft³ and 25 watts/lb at an efficiency of 10 percent.

HEAT SOURCES—The source of heat which can be used with thermoelectron engines may originate from burning of fossil fuels, from solar energy, or from nuclear energy originating in radioactive isotopes or in fission reactions. Thermoelectron engines using nuclear or solar energy have the interesting characteristic of long useful life and small weight-to-energy ratio which is of importance for space vehicle applications. Prototypes utilizing radioactive isotopes as the energy source are being delivered this December by the Thermo Electron Engineering Corporation as part of a subcontract to The Martin Co.

Demonstration units and feasibility prototypes using natural gas for heating have been exhibited and the first commercial versions will make their appearance in about twelve months. The commercial versions will be used to power small portable communications units and remote, unattended stations. They will be incorporated in household appliances where small power is required and on mobile equip-

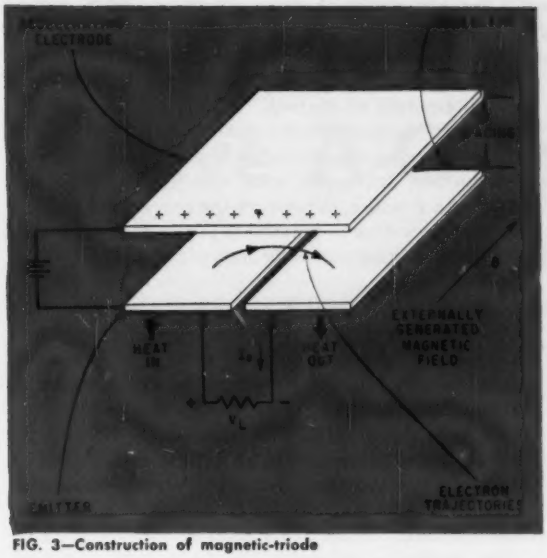

FIG. 3—Construction of magnetic-triode

ment as auxiliary power supplies. Applications to larger power requirements will follow rapidly.

ENGINE OPERATION—The principle of operation of the thermoelectron engine may be seen from the simplified diagram of Fig. 2. Electrons are emitted from a heated electrode at temperature T_1. These electrons migrate to a colder electrode which is at temperature T_2. In leaving the emitter, the electrons must do work equivalent to crossing the potential ϕ_1; on entering the collector, they give up a similar work ϕ_2. When the electrons migrate to the cold plate they build up a negative charge on the plate which is observed as an output voltage V_o between the plates.

In addition to the difference in potential given by $\phi_2 + V_o - \phi_1$, the emitted electrons must climb an adverse potential gradient which is caused by the electric field created by the electrons in transit themselves. This portion of the potential barrier, called the space charge barrier δ, must be reduced to a small value before useful power can be obtained.

MAJOR TECHNICAL PROBLEM—Principal technological problem is reduction of the space charge potential barrier which prevents flow of a reasonable fraction of the emitted electrons. Present approaches to design may be grouped according to the techniques which are employed to reduce the undesirable effects of electron space charge.

There are three general approaches: neutralization of charge by positive ions using the the gas diode[2, 3]; an engine involving auxiliary electric and magnetic fields using the magnetic triode[4, 5]; and neutralization by close spacing using the vacuum diode[1, 6, 7]. The method of close spacing seems to offer the most immediate promise of practical usefulness. Present devices having a spacing of 0.001 in. or less produce about one watt per cm^2 of electrode surface at an overall efficiency of better than 10 percent.

GAS DIODE—One approach to the neutralization by positive ions is based on maintaining a cesium pressure in the collector-emitter space. If the work function of the hot emitter is higher than the ionization energy of the cesium (3.89 electron volts), then a large fraction of cesium atoms impinging on the emitter rebound as positive ions. This process of maintaining positive ions is inherently much more efficient than ionization by electrical means.

Use of an emitter with a uniformly high work function requires excessive temperatures to maintain practical current density. Thus, most recent designs call for a composite emitter which has some areas of relatively low work function supplying copious emission of electrons and some areas of relatively high work function supplying the required ions. It is hoped that a patchy tungsten surface by its difference in work function between patches will provide the required type of an emitter.

There is a serious doubt if effective mixing of electrons and ions will result at a patchy surface. The high work function patches, which supply the ions, form at the same time potential traps which prevent the ions from spreading into adjacent areas of low work function from which the electron emission takes place. In order to prevent this trapping, a suggestion has been made to electrically insulate the adjacent alternate high and low work function areas of the emitter and then bias them to counteract trapping.

This arrangement will probably consume power to maintain the required potential difference and consequently will provide additional power loss. Also, it is probable that from a certain distance a composite work function will exhibit an effect of an average work function; therefore, the effective emission of electrons as well as ions will be governed by this average work function. Thus, it appears that a present the cesium gas diode does not offer a clear-cut solution to the problem of space charge neutralization.

MAGNETIC TRIODE—The magnetic triode consists of an emitter, a collector, and an accelerating electrode positioned as shown in Fig. 3. Electrons from the emitter are caused to follow an elongated cycloidal path to the collector by controlled electric and magnetic fields. The thermally emitted electrons absorb energy from the electric field as they rise above the cathode, but return this energy as they fall back toward the collector.

Ideally, no net energy is absorbed from the accelerating electric field. Likewise, no energy is absorbed from the magnetic field since forces are perpendicular to the electron velocity. In the absence of space charge effects and collisions with gas molecules, electrons arrive at the surface collector with the same energy with which they left the emitter.

SPACE CHARGE EFFECTS—Space charge effects are both advantageous and detrimental. As an immediate consequence of space charge, potential

distribution between cathode and accelerating plate is altered. Unless plate voltage is very high, there will be a point in the electric field near the emitter surface which has a more negative potential than the emitter.

Some of the current leaving the emitter surface can never penetrate this potential barrier. However, charges which do penetrate the barrier are all of a selected type in that they have kinetic energy higher than the barrier energy. Thus, they can all enter a collector plate having a negative potential equal to this minimum energy. Since the accelerating plate voltage controls the height of the space charge barrier, it is possible to select this potential equal to the emitter-collector (output) voltage.

If a practical magnetic triode could be constructed, it should have an efficiency greater than that of a diode of similar size by 50 to 70 percent. Difference is principally because of the reduction in heat loss by direct radiation. The accelerating plate serves as a radiation shield between the two electrodes.

Present studies of the triode are directed toward understanding and controlling the flow of electrons from emitter to collector. A small current loss to the relatively high-voltage accelerating plate constitutes a power loss which is large compared to the power gained even when a large current flows through the small output voltage. Since plate voltages are of the order of 100 volts and outputs on the order of 1 volt, the fraction of the current reaching the plate must be less than one percent of that emitted just to break even in terms of net power production.

VACUUM DIODE—The vacuum diode is the device most like that described by the principle of thermoelectron engine operation discussed previously. Current density realized is inversely proportional to the electrode spacing which must be kept small in order to get significant amounts of current and power in a device of reasonable size. Spacing of 10^{-3} cm or about 0.4 mil is required before current densities of the order of one amp/cm^2 can be reached.

Tubes with such close spacing can be made today owing to progress in the manufacture of cathodes which can be machined to close tolerances. Need for a method of supporting these electrodes to maintain their spacing creates a formidable problem. The problem is especially difficult because the support arrangement must conduct as little heat as possible since heat conducted from the emitter is lost to the conversion process. Recent techniques utilizing the difference in thermal coefficient of expansion of ceramic spacers and electrode materials have led to operational models in which tolerances of this order were maintained with relatively little heat loss.

MAXIMUM POWER DENSITY—Maximum power density which can be obtained from a thermoelectron engine is given in terms of emitter temperature (T), collector work functions (ϕ_2) and spacing (W) by

$$P = 3.701 \times 10^{-6} \sqrt{V_T} \left[\frac{(39.59 + 0.5 \ln T_1 + 2 \ln W)\, V_T - \phi_2}{W} \right]^2 \quad (1)$$

in watts per meter squared where $V_T = kT/e = T/11{,}600$ volts, k is Boltzmann's constant and e is the electronic charge.[8]

Efficiency of the thermoelectron engine is defined as $\eta = P/(q_r + q_c + q_e)$ where the heat is dissipated in three ways: radiation (q_r), conduction (q_c) and electron cooling (q_e). Radiation and conduction losses are independent of current.

Electron cooling corresponds to the total energy carried away by the electrons from the emitter, and, consequently increases with the emitter current. Since both P and q_e depend on the current, the operation corresponding to maximum power does not necessarily lead to maximum efficiency.

ELEMENT SPACING—Close spacing effectively removes the adverse effects of the space charge potential barrier. As can be seen from Eq 1, greater power density can be obtained by an increase in emitter temperature, T_1, or by a reduction in collector work function, ϕ_2. The opportunity to raise the emitter temperature is limited by the availability of satisfactory materials; however, several materials which have substantially lower work functions than those presently in use are available.

The following examples illustrate the important influence of collector work function. Using ϕ_2 equal to 1.85 volts (the value for materials which are stable, have long life and have been tested), T_1 equal to 1550 K and $W = 0.001$ cm, the power density equals 0.975 watt/cm^2 and the efficiency equals 10.2 percent. Using ϕ_2 equal to 1.1 volts (the value for materials used in photocells and the same temperature and spacing), the power density is 3.46 watts/cm^2 and the efficiency is 25.8 percent.

Conduction heat loss, q_c, used in the examples is based on a structure whose electrical leads and supports have been optimized with regard to heat conduction and I^2R loss. Cause of the large increase in power and efficiency is seen from Fig. 2. Sum $(V_c + \phi_2)$ is independent of V_c and ϕ_2. Any decrease in collector work function is a direct increase in output voltage.

COMBINATION ENGINES—It may appear that thermionic conversion is in competition with other direct conversion methods. However, because of its high operating temperature, the thermionic generator is an admirable complement to the other lower temperature generating schemes. A combination thermionic-thermoelectric generator utilizing presently available practical equipment would have an overall efficiency greater than 15 percent.

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Controlled Rectifiers Drive A-C and D-C Motors

Saturable magnetic core firing circuits can be used with controlled rectifiers to drive both a-c and d-c motors. Specific applications covered include half-wave and full-wave control circuits

By **W. R. SEEGMILLER,** Magnetic Controls Engineer, General Electric Co., Schenectady, N. Y.

CONTROLLED RECTIFIERS are rapidly gaining acceptance as an effective means of reducing size and weight and increasing efficiency in power stages of control equipment. Because the controlled rectifier is similar to the thyratron, it can be used in many applications where thyratrons, magnetic amplifiers, power transistors, relays and switching devices are now used. These applications include drives for d-c torquers, a-c servo motors, d-c power supplies and power oscillators.

Characteristics

The gate firing characteristics (gate voltage versus gate current) of a controlled rectifier are shown in Fig. 1. These characteristics are important in the design of firing circuits for the controlled rectifier. The rectifier will fire at some gate current-voltage point within the shaded area. Reverse gate current out of the gate terminal should be limited by a diode in series with the gate lead if reverse voltage appears in the gate circuit.

Another plot of the gate firing characteristic of a typical controlled rectifier is shown in Fig. 2. This is a plot of the gate current required for firing as a function of temperature and applied forward voltage. Although these curves will vary somewhat from unit to unit, they clearly indicate the temperature dependency of the firing characteristic and the resulting importance of this dependency should be considered when designing firing circuits.

To provide for firing of the controlled rectifier at a definite point in the supply voltage cycle, it is necessary to apply a current pulse with a steep wavefront. Circuits utilizing saturable magnetic cores in a manner similar to magnetic amplifiers are a convenient means of generating this steep wavefront. Although the controlled rectifier actually requires only a very short pulse of a few microseconds duration to fire, the gate current may be continued throughout the remainder of the firing half cycle without adversely affecting the rectifier.

A typical half-wave circuit is shown in Fig. 3. The firing circuit consists of the saturable magnetic core with gate winding N_G, control winding N_C, current limiting resistor R_1, diode D_1, shunt resistor R_2, and supply voltage e_{ss}. Diode D_1 prevents reverse voltage from appearing on the gate terminal of the controlled rectifier.

Current in the control winding determines the time in the cycle at which saturation occurs. The saturation angle, thus, can be varied from zero to 180 electrical degrees

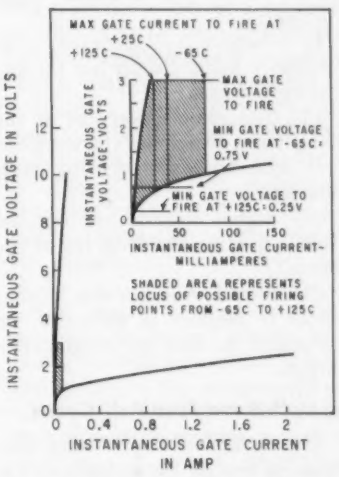

MAX GATE CURRENT TO FIRE AT
+25C
+125C
-65C
MAX GATE VOLTAGE TO FIRE
MIN GATE VOLTAGE TO FIRE AT -65C = 0.75 V
MIN GATE VOLTAGE TO FIRE AT +125C=0.25V
INSTANTANEOUS GATE VOLTAGE-VOLTS
INSTANTANEOUS GATE CURRENT-MILLIAMPERES
SHADED AREA REPRESENTS LOCUS OF POSSIBLE FIRING POINTS FROM -65C TO +125C
INSTANTANEOUS GATE VOLTAGE IN VOLTS
INSTANTANEOUS GATE CURRENT IN AMP

FIG. 1—Gate firing characteristics of C35 controlled rectifier show variation of gate firing point with temperature. This temperature dependency must be considered by the engineer when he is designing firing circuits for controlled rectifiers

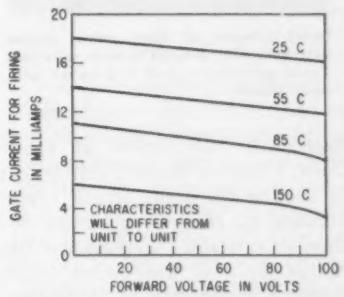


FIG. 2—Temperature variation of characteristics are shown

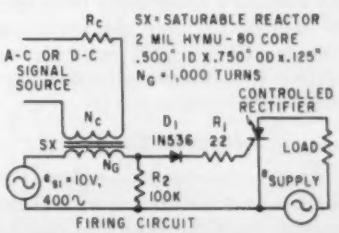
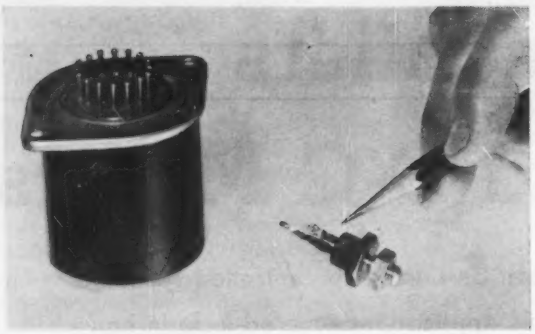


FIG. 3—Basic circuit for motor control



Controlled rectifier replaces magnetic amplifier

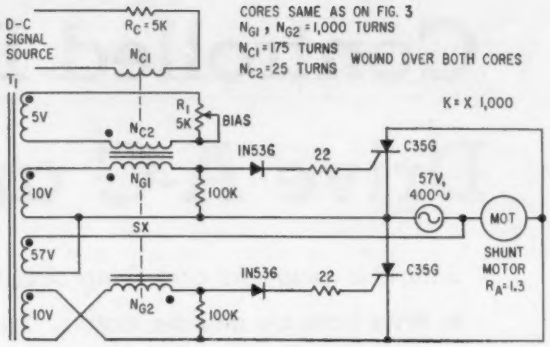
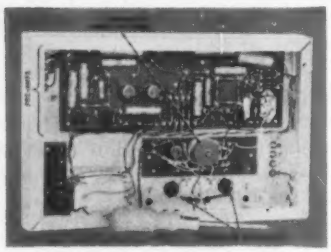


FIG. 4—Drive circuit for reversible d-c shunt motor

in a manner similar to magnetic amplifiers.

Firing circuit design values given in Fig. 3 are for a 400-cycle supply frequency. The circuit is designed for a peak gate current of 200 milliamps. With this firing circuit the controlled rectifier fires over a range from 30 to 150 electrical degrees at minus 65C or from 10 to 170 electrical degrees at normal room temperature.

For complete 0 to 180 electrical



Series actuator of flight control system uses controlled rectifiers to drive solenoids. Circuit can also be used to drive d-c split-series motor

degree coverage under all conditions, a square wave of voltage can be used as the firing circuit supply voltage, e_{s1}. The firing circuit will then operate along a single load line independent of the firing angle. Another alternative is to increase the magnitude of the sinusoidal supply and use a Zener diode from gate to cathode to limit the maximum voltage. However, in most control applications this complete coverage refinement is not necessary.

Saturation Current

Another point to be considered in the design of the firing circuit is the magnitude of the saturable reactor exciting current before saturation. Design values given in Fig. 3 keep the maximum exciting current over the normal control range below 0.5 ma.

Since the magnitude of the exciting current will rise with large negative values of control current it may be necessary, in some applications, to limit the maximum value of control ampere-turns. Where the magnetic core firing circuit is being driven by a preamplifier, this limiting will be accomplished by saturation of the preamplifier output. Since the rectifier will not fire below 0.25 v (Fig. 1), a safety margin can be obtained by adding a 100-ohm resistor shunted from the gate terminal to cathode terminal of the rectifier. This insures that more than 2.5 milliamps of exciting current is required before the gate reaches 0.25v—the minimum firing voltage.

In summary, the saturable magnetic core firing circuit has the following features:

(1) The steep wavefront of the firing pulse overcomes the temperature dependency of the firing characteristic.

(2) Signal circuits are isolated from each other and from the power source.

(3) Signal windings can be connected to respond to either a-c or d-c signal sources or preamplifier outputs.

Half-Wave Push-Pull Circuit

An application of controlled rectifiers to control the armature of a d-c shunt motor or d-c torquer is shown in Fig. 4. This circuit is for applications requiring a push-pull output for a reversible drive. To keep the number of control components to a minimum, a half-wave output circuit is used. The firing circuit is of the type previously discussed. The saturable reactor control windings are wound over both cores together. The bias winding is connected to the a-c supply in the proper polarity to retard the firing angle on each core.

At standby, the firing angle on each controlled rectifier is set with the bias adjustment potentiometer R_1 to approximately 160 electrical degrees.

There is a small a-c component of current through the armature at standby. Power dissipated in the armature by this a-c component is kept small by adjustment of the standby firing angle.

The signal winding is connected to a d-c control source and the gate winding polarity is such that a d-c signal retards the firing angle on one core and advances the firing angle on the other core.

Recordings of the armature current acceleration and reversing are shown in Fig. 5. Armature current

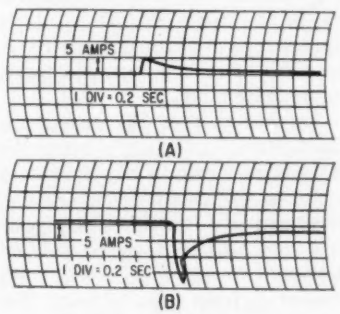


FIG. 5—Armature current zero to top speed (A) and during reversal from top speed in one direction to top speed in the other (B)

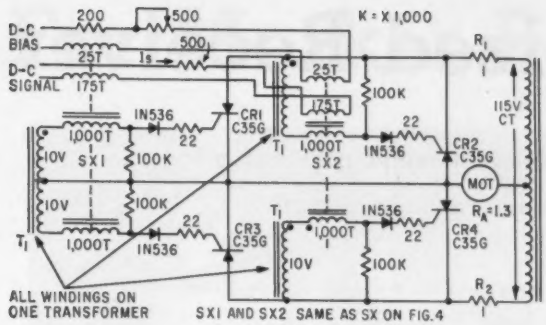


FIG. 6—Full-wave circuit is used for d-c shunt motor or d-c torquer

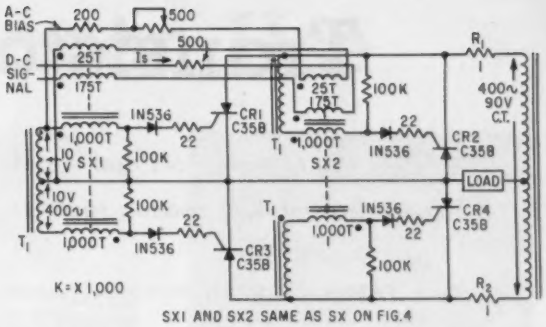


FIG. 7—Drive for a-c motor is very similar to that for d-c

during an acceleration from standstill to top speed is shown in Fig. 5A. Maximum current during a reversal from top speed in one direction to top speed in the other direction is approximately 20 amp as shown in Fig. 5B. The current drops to 10 amp in less than 0.1 sec, well within the capability of the C35 controlled rectifier.

With high inertia loads the high armature current during reversals is extended for longer periods of time, depending on the torque to inertia ratio. In some applications it may then be necessary to limit the armature current to protect the rectifier from these high currents during reversals. The maximum values of current that can be tolerated will depend upon ambient temperature, type of heat sink and duty cycle of the particular application.

Full-Wave Push-Pull Circuit

A circuit for full-wave push-pull operation of a d-c shunt motor, or d-c torquer, is shown in Fig. 6. This circuit requires four controlled rectifiers and a center-tapped transformer. The magnetic core firing circuit is similar to that described previously, except that four cores are required for the full-wave push-pull action. Limiting resistors R_1 and R_2 are required to limit the standby current when two of the controlled rectifiers, such as CR_1 and CR_4, (which operates on the same half-cycle) are both turned on at the same time.

The full-wave push-pull circuit of an a-c servo motor, Fig. 7, is identical to the circuit used for the full-wave push-pull d-c shunt motor drive except for a different arrangement of the firing circuit. Limiting

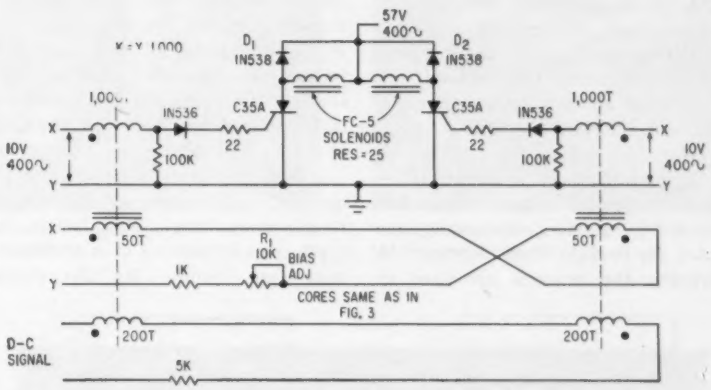


FIG. 8—Solenoid drive circuit can also be used to drive d-c split-series motors

resistors R_1 and R_2 are again used to limit the standby current.

Figure 8 can replace the half-wave magnetic amplifier stage used to drive the solenoids in the series actuator of a flight control system. The circuit consists of a controlled rectifier in series with each solenoid and a saturable magnetic core firing circuit. Each magnetic core has two control windings, one for adjustment and the other for signal.

Potentiometer R_1 provides for adjustment of the standby firing angle and standby current in the solenoids. Increasing R_1 will increase the standby current in each solenoid.

The signal windings are connected in the proper polarity to increase the current in one solenoid and decrease the current in the other solenoid. Free-wheeling rectifiers D_1 and D_2 provide a path for continuous flow of current in the inductive load during that portion of the cycle when the controlled rectifier is not conducting. Response time of the saturable magnetic core firing circuit is similar to a half-wave magnetic amplifier; approximately one-half cycle of supply frequency.

The circuit shown in Fig. 8 can also be used to drive a d-c split-series motor. The windings of the motor replace the solenoids shown.

Applications

Because controlled rectifiers offer a significant reduction in size and weight in the power stages of control equipment, the application possibilities for these rectifiers are almost unlimited. This is especially true in applications requiring load powers of 10 watts and upward, which are presently being supplied by magnetic amplifier output stages.

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Proceeding of National Electronics Conference, Oct. 15, 1958.

Transistorized Receiver

Efficient use of transistors and the elimination of relays produces a compact, economical marker beacon receiver suitable for light aircraft

By **F. PATTERSON SMITH,** National Aeronautical Corporation, Fort Washington, Pennsylvania

AN AIRCRAFT MARKER BEACON receiver furnishes the pilot of a plane with information as to his position as he flies over marker beacon transmitters. The transmitters are located along the main air lanes and are coded by modulation and pulsing.

Beacons that are primarily route markers are amplitude modulated at 3,000 cps and are sometimes pulse coded for further identification. At airports, the beacons are used in instrument landing systems. A beacon located about five miles from the airport is called the outer marker. It is modulated at 400 cps and pulsed to give two dashes per second. Passage over the beacon is the signal to begin the descent at a specified rate.

Another beacon, called the middle marker, is mounted about ½ mile from touchdown. Modulation is 1,300 cps and pulsing is in alternate dots and dashes. As the plane passes over this station, procedure requires the pilot to make a new approach if the runway is not visible.

The transmitters all operate at a fixed 75 mc and modulation is 95 percent. Transmission is directed upward in a relatively small angle cone. These points are illustrated in Fig. 1.

FIG. 1—Enroute beacons are sometimes pulse coded for further identification. The outer marker is pulsed at two dashes per second and the middle marker with alternate dots and dashes

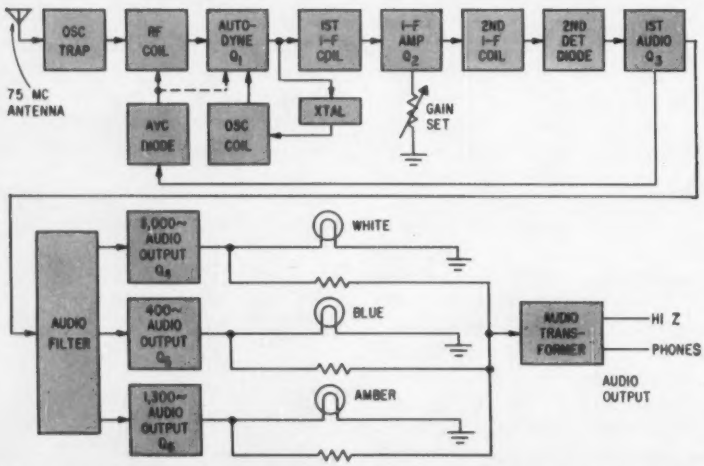


FIG. 2—Crystal-controlled autodyne oscillator provides maximum gain with minimum number of parts. Output transistors replace commonly used relays

Low-Cost Receiver

In the light aircraft field—private and small commercial planes—equipment cost, size and weight are important factors. Marker beacon receivers for this use have been primarily of the trf type; typically, they provide the pilot with aural signals only. Airline type receivers present information with colored lights: white for enroute beacons, blue for the outer marker and amber for the middle marker.

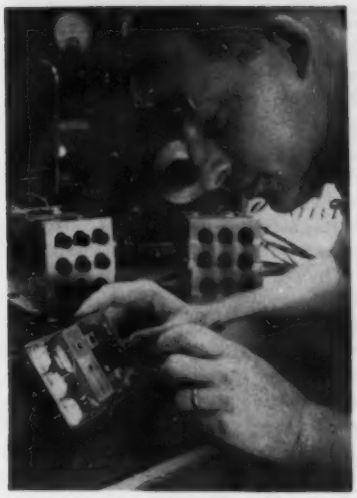
Three-lamp indication can be designed for a trf receiver but spurious signals, primarily from tv broadcasting stations, can cause a lamp to light. When visual indication is provided, this type of interference cannot be tolerated. With only aural indication, the interfering signal will not be confused with the tone from the marker beacon.

To meet the needs of the light plane field, an inexpensive superheterodyne receiver has been developed that provides both aural signals and airline-type colored lights. The unit is shown in the photographs.

Light output from the lamps is adequate for bright daylight operation and dimming is available for night instrument landings. Antenna sensitivity is 1,000 microvolts and is based on antenna efficiency and field strength of the radiated signal. Higher sensitivity would

For Marker Beacon Use

Pilot adjusts brightness of indicator on marker beacon receiver. Reverse side of front panel is specially labeled to permit vertical mounting



Receiver dimensions are 1 3/32 × 3 13/32 × 7⅛ inches. Weight is 18 ounces

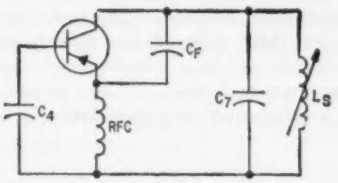


FIG. 3—Basic vhf oscillator circuit showing signal paths only

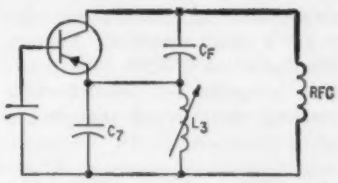


FIG. 4—Tank circuit is shifted to emitter load

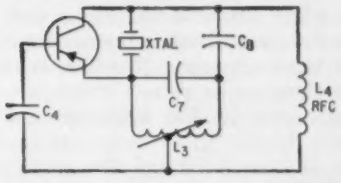


FIG. 5—A crystal and a neutralization circuit are added to the oscillator of Fig. 4

provide a broader fix; lower sensitivity might be inadequate at high altitudes.

Crystal Oscillator

A block diagram of the single-conversion, all-transistor receiver is shown in Fig. 2. It uses an autodyne front end for maximum gain with a minimum of components. The conversion gain of an autodyne may be higher than an r-f amplifier for the same transistor. The autodyne also gives less variation in gain for a given parameter spread and thus a relatively inexpensive transistor can be used. The local oscillator frequency was carefully chosen to keep spurious responses at frequencies where there is little interference. This approach permits low-insertion loss circuits to be placed ahead of the autodyne.

Oscillator frequency is 68.75 mc and i-f frequency is 6.25 mc, thus image response is at 62.5 mc which is 1.25 mc above the picture carrier in tv channel 3.

The crystal-controlled vhf autodyne circuit evolved from the basic vhf oscillator circuit shown in Fig. 3. The transistor operates in the common base mode using a tank circuit and feedback through C_f. This circuit was revised, Fig. 4, to allow both input leads, base and emitter, to be a-c grounded at other than the oscillator frequency.

Crystal control was instituted by replacing C_f with an overtone crystal in the feedback path. Neutralization is necessary and is accomplished by C_n in combination with the phase reversal of coil L_3 as shown in Fig. 5. The signal circuits were then added to the basic oscillator circuit to give the final circuit indicated in Fig. 6.

The problem of local oscillator radiation from the receiver was solved by placing a series tuned trap, L_1C_1, in the antenna circuit, tuned to the oscillator frequency. This ensures that the base circuit is well grounded at the oscillator frequency, improves the image ratio, and introduces little insertion loss. Maximum 75-mc gain is achieved with the trap properly tuned.

The i-f amplifier is standard and is reasonably neutralized to prevent regeneration. The i-f coils are designed for matched gain and have an insertion loss of 3 db each. Resistor R_{11} in combination with R_{12} and R_{13} establishes the bias on this stage for maximum gain. After alignment, R_{13} is bridged with a selected resistor R_7 to reduce the receiver gain to the required value. A control range of approximately 20 db is obtained by this method,

without appreciably deteriorating the avc characteristic.

Automatic Volume Control

When the voltage drop across the audio d-c collector load resistor R_{10} exceeds the value established by the voltage divider consisting of R_2 and R_3, avc diode D_1 goes into conduction. This diode loads antenna coil L_2 to reduce receiver gain. If the dynamic range of this circuit is exceeded, further current drawn through D_1 will reduce the collector current of autodyne transistor Q_1 by increasing the drop across its emitter resistor R_4. This gives approximately 10 db additional control range. If emitter current control of the autodyne were carried too far, it could result in oscillator "squegging".

Filter Design

The audio filter to separate the three channels is designed for constant loaded input impedance, matched gain and maximum loaded Q. Filter output is matched so that receiver sensitivity is the same for all three channels. This requires matching audio output transistors Q_4, Q_5 and Q_6. The nonlinear load presented by the output transistors required an empirical filter design.

Audio output transistors Q_4, Q_5 and Q_6 function as a combined rectifier and single-ended class-B power amplifier. Collector current is a half sinusoid until the stage is over driven. As the signal level increases, clipping occurs until, at medium signal levels, the output waveform is essentially a square wave.

Light output is not a linear function of lamp current. The steep slope of the curve improves the low-level noise rejection. The slightly non-flat top of the lamp input to light output curve, however, permits more accurate location of the center of the transmitted field than is possible with relays.

The three outputs are matrixed into a common audio lead and applied to transformer T_1. The transformer provides a power match between the matrix resistor source and the headphone load, providing about 15 mw to 600-ohm earphones. Another winding gives about 4 volts rms for a cabin amplifier. Though audio distortion is high, tonal quality is adequate for identification purposes, which is all that is required.

Nominal operating voltage is 13.75. With no signal, current drain is 5 ma; with maximum signal, 195 ma. Thus a separate power switch is not provided. Satisfactory operation is obtained with supply voltages from 11 to 16 volts and power supply transients of the type normally encountered in aircraft radio installations will not damage the receiver. Transients will normally be inaudible. With minor modifications, nominal 27-volt operation is possible.

As noted earlier, the receiver image frequency is 62.5 mc within the band of tv channel 3. Measurements with 400-cps modulation show a typical image rejection of the r-f system alone of 25 db. Rather than simulate an accurate tv signal, flight tests were used to check the design.

Flights were made in the vicinity of the Empire State Building, from which channels 4 and 5 are broadcast, and in the Philadelphia area which uses channels 3 and 6. Within one half mile of the radiating antenna, at an altitude close to maximum radiation, no light output or audible buzz was detected.

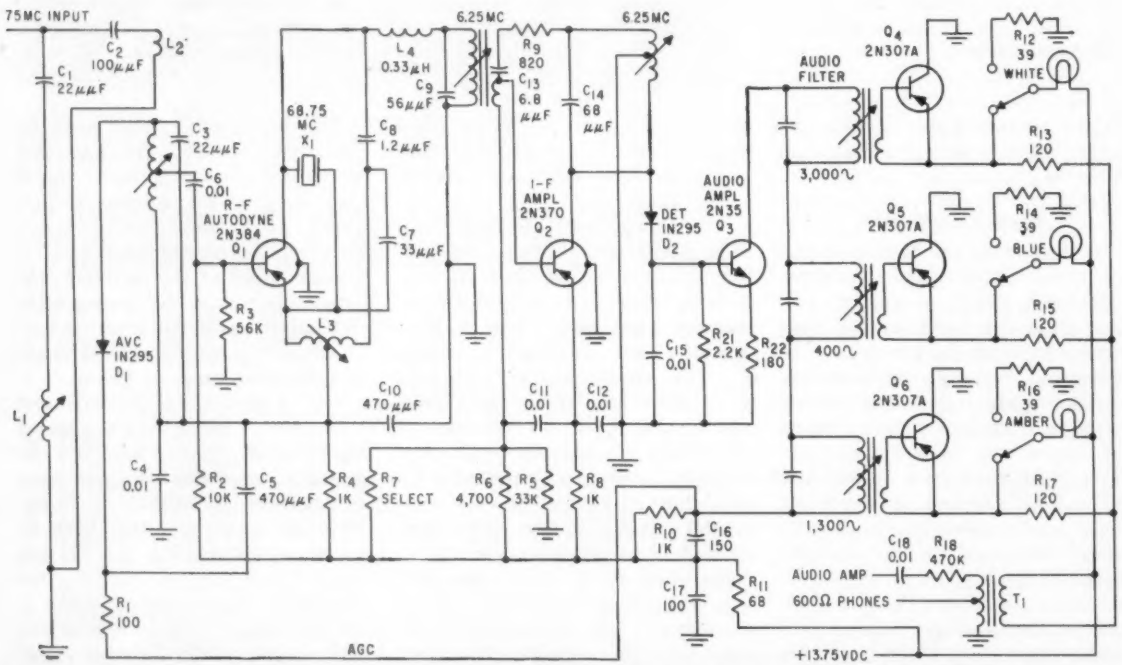
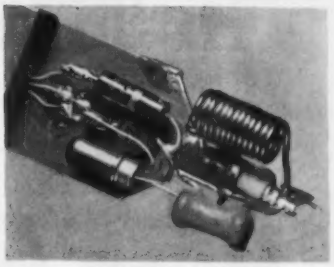


FIG. 6—Transistorized marker beacon receiver gives audio output as well as the colored light presentation typical of airline type units. Careful, efficient design gives performance comparable to more complex equipment

Versatile F-M Transducer

Single-transistor oscillator on phonograph pickup arm is frequency modulated by stylus. Radiated signal goes to monitoring receiver



Oscillator is mounted on phono arm

By C. S. BURRUS, E. E. Dept., Rice Institute, Houston, Texas

SOME ADVANTAGES of the pickup system to be described are light weight, no need for connecting wires, excellent frequency response and insensitivity to hum. These and other qualities make this type of pickup useful in locations that are inherently difficult to monitor.

Success of this oscillator has pointed to several possible uses in measurement. Measurement of temperature using a bistable element, of pressure using a metal diaphragm, of voltages using a voltage-variable capacitor, or of mechanical vibrations in different locations are possible.

Circuit Description

Frequency of oscillation is determined by L_1, C_1, C_2, and the output capacitance of Q_1 (Fig. 1). Capacitor C_1 is formed by a stationary plate and the stylus arm, which are separated by approximately 0.025 in. They have a common area of approximately 0.0064 in^2 to give a static capacitance of approximately 0.06 $\mu\mu f$. The variation of this value produces the frequency modulation.

Since the emitter-to-base impedance is very low, the feedback element C_2 is also across the tank. Output capacitance of the 2N588 is a function of frequency and collector current; at 100 mc and 3 ma circuit output capacitance is about 2 $\mu\mu f$. This gives a total, including strays, of approximately 9 $\mu\mu f$ which requires L_1 to be 0.34 μh. Thirteen turns of No. 20 wire, 0.25 in. in diameter gives this value at a Q of 160.

The 500-ohm emitter resistor and the 1.5-v battery establish the 3-ma collector current; this combination and 6 v on the collector provide strong oscillation. A single-battery supply could be used with appropriate biasing resistors.

The common-base configuration was chosen because of economy of parts and ease of obtaining feedback. Feedback is through C_2 to the emitter. It would probably be better to bring C_2 to a tap down on L_1 and use a larger value of C_2.

Linearity

Two inherent sources of nonlinearity in this system must be minimized. First, frequency varies with the inverse square root of tank capacitance and second, capacitance varies with the inverse of the spacing of the plates. By padding the varying capacitor C_1 with C_2 and the transistor's output capacitance, the ratio of fixed to variable capacitance is large enough that frequency varies very nearly linearly with C_1. To reduce distortion from the relation of C_1 to spacing, the fixed spacing is made large compared to the expected deviations. With this arrangement only on extreme excursions that place the stylus arm near the fixed plate is there appreciable distortion.

The frequency deviation must be such that the receiver's band width will accept all the side bands. This is controlled by the amount of padding of C_1. Fortunately, the padding necessary to reduce the frequency swing to approximately the same as that of broadcasting stations is also sufficient for the reduction of the nonlinearity mentioned above.

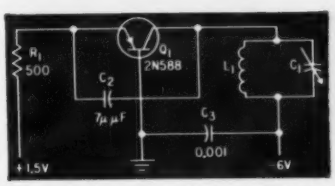


FIG. 1—Stylus varies C_1, thus modulating the oscillator

Construction

The entire assembly with the exception of the batteries is mounted at the head of the phono arm and is no larger than most magnetic pickups. The plate that supports the assembly is of ⅛ in. copper and is common to the 6-v battery lead. A small ceramic stand-off insulator supports the fixed plate of C_1. Also connected to this point is L_1, C_2 and the collector lead of Q_1. By-pass capacitor C_3 is positioned between R_1 and the transistor. The assembly is made rigid since the pickup tends to be microphonic. Cost of parts is less than 10 dollars.

Performance

Frequency response of the pickup system is determined by the stylus assembly, the arm, and the f-m receiver. The h-f limit is determined by the mass, compliance, and self resonance of the stylus assembly and the low frequency limit is determined by the tone arm's ability to remain stationary as the stylus moves. The constructed unit was flat from 30 to 15,000 cps. The range was probably greater but this was the limit of the test record. This device is displacement sensitive, not velocity sensitive as are magnetic pickups. It tracked reliably at less than one gram.

Using Digital Techniques in Time Encoders

Here's a method of generating a time scale for tape and paper in a form that can be quickly interpreted. Digital circuits and glow-tube counters form logic chains that evolve a time code from an oscillator timing base

By R. J. SULLIVAN, I. EASTMAN and I. C. CHANOCK,
Edgerton, Germeshausen & Grier, Inc., Boston, Mass.

As THE VOLUME of data gathered by high-speed multichannel recorders increases, the readout task becomes not only laborious, but sometimes frightening. The time marks generator to be described has helped solve the problem of reading out more than 2 million channel-feet of chart records and magnetic tape in the instrumentation phase of performing static tests of a nuclear missile engine.

Formerly, time coding, on paper charts for example, consisted of placing a mark on the chart at regular intervals as short as one second. If finer time resolution was required, a sinewave was superimposed on the record at frequencies up to 100 cps. To correlate a deviation on one chart with an event or deviation on another chart, the operator would have to locate a known time reference on the chart and count the number of timing marks or cycles to the event.

Where magnetic tape was used, the problem was not as acute. Time coders were available that would store the elapsed time on the tape in binary form at high repetition rates. However, readout required the use of expensive binary-to-decimal translation equipment.

The time marks generator records elapsed time every 20 millisec in simple decimal code on magnetic tape. When the magnetic tape is used with a paper-chart recorder, resolution is limited by the writing speed of the recorder. Nevertheless, the time-marks generator has its greatest value when used with paper recorders for, here, the elapsed time is written on the chart in decimal notation and can be read out directly from the record. With only a few minutes of training, an operator can read elapsed time from the record with not much more effort or skill than is needed to scan a column of sequential numbers.

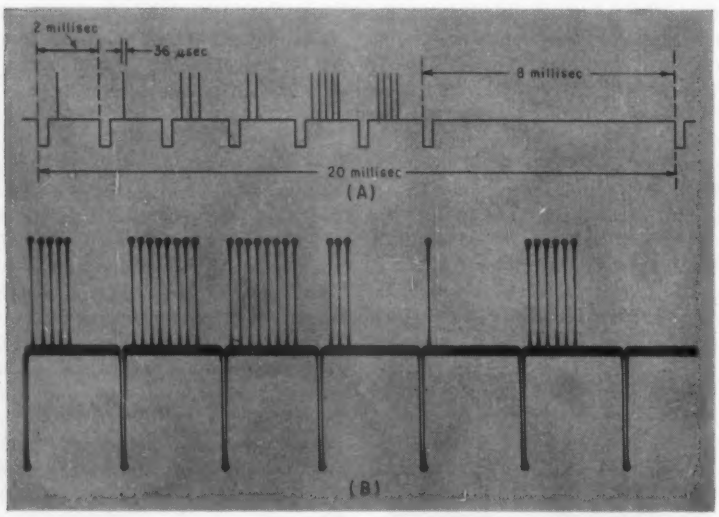


FIG. 1—Representation of time code (A); actual oscillographic recording shows 5,883.16-sec elapsed time (B)

Time Code

Elapsed time from a zero reference (which is defined as the time the time marks generator is started) is registered on tape in code every 20 millisec. The basic element of the code, illustrated in Figure 1A, is a 20-millisec timing cycle within which the elapsed time is presented in decimal form. Each timing cycle is divided into 2-millisec intervals. Each of the first six intervals (from left to right) represent decades of time. The initial interval indicates thousands of seconds, the second interval indicates hundreds of seconds, and so on in descending orders to the sixth interval which contains hundredths-of-sec information. The last four of the 2-millisec intervals contain no time information, serving only as a convenient way of separating one cycle from the next.

The time marks appear as sharp spikes during the appropriate decade interval; one spike represents the number ONE, eight spikes represent number EIGHT, etc. In Fig. 1A for example, after 56,627 timing cycles the elapsed time would be

1,132.54 sec (56,627 × 20 millisec).

The code group for 5883.16 sec is shown in Figure 1B.

The time marks generator can record elapsed time from zero time, in 20-millisec steps, through 9,999.98 sec.

Circuit Functioning

Time base of the generator's counting system (Fig. 2) is a 55-kc crystal-controlled oscillator. The oscillator output goes to a wave-shaping circuit and then is divided by two to produce a 27.5-kc square-wave output. Thereafter, all counting is performed by 9 glow tubes (V_1 to V_9) and their associated circuits. The time-marks generator schematic is shown in Fig. 3.

The 27.5-kc output (an 18-μsec pulse every 36 μsec) is applied to glow tube V_1, a divide-by-5 counter. (Input pulses to all glow tubes pass through their associated driver stages.) Tube V_1 transmits one pulse to V_2 for every five pulses it receives. This pulse is 36-μsec long and occurs once every 181 μsec. A second identical output from V_1 goes to input No. 1 of the timing marks AND gate.

Tube V_2 has two outputs. The first output, a 181-μsec pulse every 2-millisec, goes to the output stage and establishes the 2-millisec timing interval; it also goes to V_3. The second output, derived from cathodes 1 to 9 of V_2, is a continuous train of pulses, each essentially 181-μsec long. These pulses are applied to transistor switching circuits.

Consider two functions which have been accomplished up to this point. First, a series of 36-μsec spikes, one every 181 μsec, has been applied to input No. 1 of the time marks AND gate. Second, 181-μsec-long pulses have been applied to the transistor switching circuits. Now V_3, the control tube, in conjunction with counting tubes V_4 through V_9, determines how many 181-μsec pulses will be applied to input No. 2 of the time marks AND gate and, hence, how many 36-μsec spikes will be gated into the output stages.

Tubes V_4 through V_9 are counting tubes with inputs of one pulse each 20 millisec, 100 millisec, 1 sec, 10 sec, 100 sec, and 1,000 sec, respectively; output-pulse durations are shown on the tube blocks (Fig. 2).

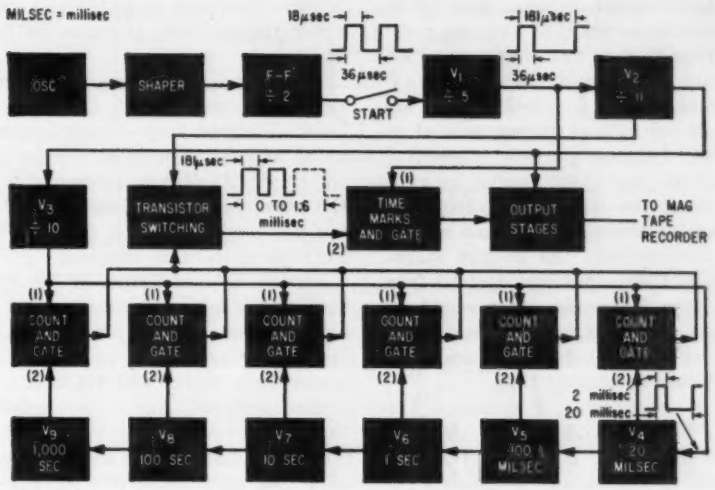


FIG. 2—Block diagram does not show all outputs of tubes V_2 to V_9 and all outputs of counting and gates. Tube V_2 actually has 9 possible outputs going to input (2) of its gate

This line-up of tubes gives the system its capability of counting up to 9,999.98 seconds in 20-millisec steps from time zero. At any moment, the elapsed time to the last timing cycle can be determined by the condition of the counting-tubes' cathodes.

Each counting tube not only has an output to the next counter, but has a second output which goes to Input No. 2 of its associated counting AND gate. This output comes from the cathodes of the counting tube. For example, tube V_4 has an output to the next stage which consists of a 20-millisec pulse every 100 millisec. During the time between these pulses the cathodes of V_4, in sequence, produce pulses at a 20-millisec rate (the rate at which V_4 is being driven by V_3). The cathode arrangement of V_4 is such that V_4 divides by 5 and five cathode outputs go to the counting AND gate.

For simplification, Fig. 2 shows a single input to each of the No. 2 inputs of the counting AND gates. The gates corresponding to tubes V_5 to V_9 actually have 9 inputs. Since one of the cathodes of each of tubes V_4 to V_9 must carry a count (for example, *zero*) each counting AND gate always has a voltage at its No. 2 input.

The cathodes of V_2 are energized in sequence by V_2 at a 2-millisec rate. The first six of these cathodes, in turn, provide a pulse to input No. 1 of a counting AND gate. That is, cathode 0 of V_2 is tied to the 1,000-sec AND gate, cathode 1 is tied to the 100-sec AND gate, and so on. The last four cathodes of V_2 shunt all signals to ground, thereby producing the time separation between information in one timing cycle and the start of the next timing cycle. Hence, for only 2-millisec, each of the counting AND gates, in turn, has a pulse at its input No. 1, starting with the 1,000-sec circuit.

The No. 2 side of each counting AND gate always has a pulse on it, and side No. 1 has a pulse for only one 2-millisec period during the timing cycle. Whenever this gate detects a coincidence of pulses at its inputs, it produces an output. Since V_2 controls the order in which the gates are pulsed, outputs appear first in the 1,000-sec decade gate, then in the 100-sec decade gate, and so on.

Each of the gates corresponding to tubes V_5 to V_9 has 9 outputs and the V_4 gate has 5 outputs. The only gate output that appears at one time is the output that corresponds to the condition of its glow tube. Each gate output controls one of the transistor switching circuits.

For example, each of the cathodes of V_5 has an input to the 100-millisec counting AND gate. An output from cathode 4 of V_5 would produce an output at this gate when V_2 pulses gate input No. 1. This gate output causes the appropriate tran-

sistor switch to pass four of the continuous train of 181-μsec pulses from V_2 into the time marks AND gate. The time marks AND gate would detect a coincidence of signals for 36 μsec during each of the four 181-μsec periods. Therefore, for 36-μsec, spikes would be gated out of the time marks AND gate, passing through mixer and emitter followers into the output stages. Since the output was derived from V_6, the four spikes that would appear on the tape in the space provided for that decade indicate 400 millisec of elapsed time.

In registering a complete six-digit decimal code on tape, the process described is repeated during each of the decade intervals. The condition of the associated counting tube is reflected in the number of spikes that are recorded during each decade interval. After six intervals have passed, a complete number has been recorded and another timing cycle is ready to be started.

The authors have described only the 20-millisec system. Other systems developed have timing cycles up to 500 sec. The basic design is sufficiently flexible to accommodate the characteristics of most recording equipment. Only a change in the code pattern is required.

During data reduction or record analysis from magnetic tape, a companion equipment, the time-interval tape searcher, monitors the recorded code marks and initiates a command signal when a preselected time is sensed on the record. A typical example can be taken from an actual application for the Signal Corps. Often, it was necessary to transcribe data from certain portions of tape to paper charts so that the data could be more conveniently studied. Knowing the elapsed time to the event of interest, the operator would preset the time-interval tape searcher to that time. The instrument would then monitor the time marks on the tape at high playback speed and would intiate a command signal when the preset time was sensed. At the initiation signal, a paper recorder would begin to transcribe on a 32-times-expanded scale the data stored on the tape. A second preselected time-marks signal would stop the transcription.

During playback from magnetic tape without the time-interval tape searcher, elapsed-time readout can be accomplished either as a counting-tube presentation or as an oscilloscope display in decimal form. This capability enables the operator to run the tape at high scanning speeds to an elapsed-time region of interest. The recorder can then be run at slower readout speeds to a particular elapsed time.

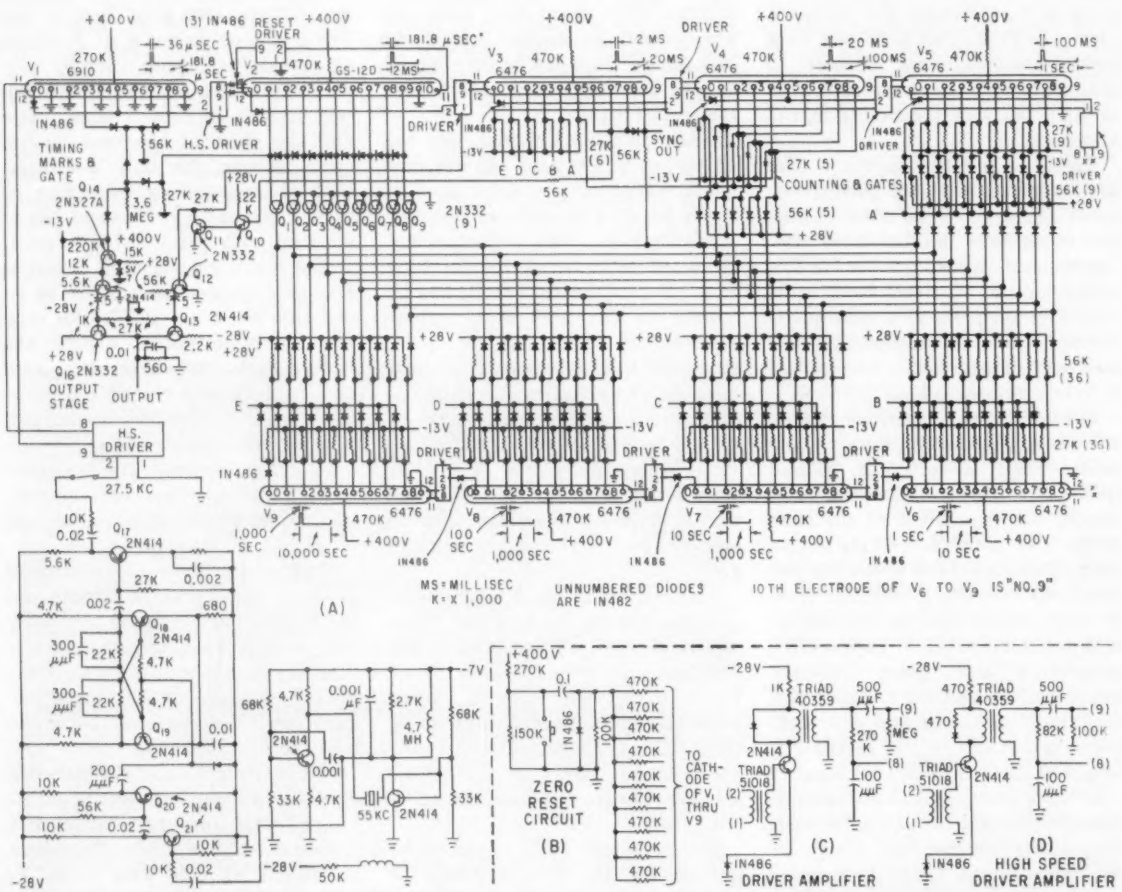


FIG. 3—Time marks generator (A); partially enclosed by dashed line are the zero-reset circuit (B), driver amplifier (C) and high-speed driver (D)

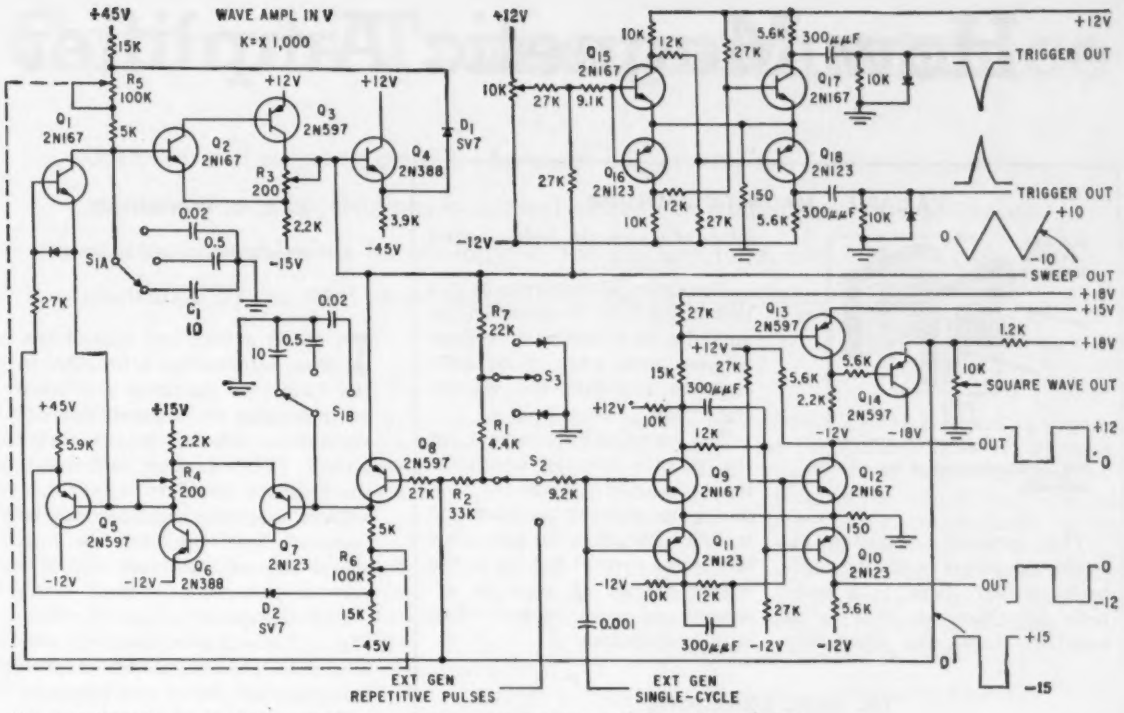


FIG. 1—Resistors R_7, R_1, R_2 of the waveform generator sum sweep-output and Q_{11}-emitter voltages

Multi-Waveform Generator

Features double-bootstrap sweeps which generate a triangle-shaped wave. A polarity-sensitive trigger circuit controls these sweeps

By JAMES E. CURRY, Tasker Instruments Corp., Los Angeles, Cal.

WAVEFORMS GENERATED are triangle, rising and falling sawtooth, and square. In addition, tnere are two trigger outputs. The generator can be free running or driven by an external generator. The following circuit discussion describes the free-running mode.

Double-bootstrap sweeps Q_1 to Q_4 and Q_5 to Q_8 (Fig. 1) are controlled by the polarity-sensitive-trigger circuit Q_9 to Q_{12}. In turn, the sweep output controls this trigger circuit, switching trigger input transistors Q_9 and Q_{11} when the normally triangle-shaped output goes to its positive and negative apexes (± 10 v).

The sweep circuits are complements of one another. Switching transistors Q_1 and Q_5 of the sweeps are controlled by Q_{10}, whose output depends on the state (ON or OFF) of Q_9 (and Q_{11}).

When either Q_1 or Q_5 is saturated, the input of one sweep circuit is tied to the output of the other. When, for example, Q_5 is tied to C_1, capacitor C_1 charges towards a voltage that corresponds to the triggering point. This point is reached when the collector of Q_3 (the sweep output) drops to −10 v.

The actual firing points of Q_9 and Q_{11} are + and −0.15 v, respectively (measured at junction of R_1 and R_2).

Zener diodes D_1 and D_2 simulate constant-voltage sources in the feedback paths of the sweeps.

Potentiometers R_3 and R_4 compensate for voltage drops between inputs and outputs of the bootstraps. Frequency on any range can be modified by a factor of 20 by R_5 and R_6. Switches S_{1a} and S_{1b} vary rising and falling portions of the triangle wave.

When using external repetitive pulses as triggers (with S_2 at *ext gen*), the frequency of the external generator must be greater than that of the waveform generator. When driven by a sine or triangle-wave generator, sweep output is 90 deg out of phase with the input.

When using an external trigger to gate one cycle of the waveform generator, S_2 is thrown to one of its diode positions.

How Magnetic Amplifier

By C. C. WHITEHEAD,

Wimbledon, London, England

IN MANY SERVOS and control systems, information is provided in the form of a changing resistance or impedance by a potentiometer, variable resistance or inductance pickoff. If this arrangement shunts the feedback rectifiers, a very convenient magnetic amplifier can be designed that provides its own source of control current, which is very advantageous in some cases.

Before explaining the amplifier, Fig. 1, it is well to review the variable μ principle as applied to an electron tube, and follow this summary with the derivation of the magnetic amplifier.

Variable μ

A means was sought to control the inherent gain of an electron tube when used as a voltage amplifier. Since μ is the deciding parameter in this application, it was obvious that some way of changing μ while the tube was in operation would be needed. This is done by making the control grid helix or mesh with wires which do not have a constant diameter/spacing ratio.

Usually the grid wire diameter is constant and the spacing varied. In this case, μ is an inverse function of the grid wire spacing. Then as the grid potential $-V_g$ is increased, the anode current from that portion of the cathode surface underlying the more closely spaced, higher μ, grid structure is cut off, leaving the more widely spaced, lower μ, part of the grid structure still effective. Thus, as $-V_g$ is increased, the effective value of μ is reduced.

But while this takes place, another effect is usually of greater importance. Cutting off the anode current from the part of the cathode underlying part of the grid structure reduces the cross section

VARIABLE-μ MAGNETIC AMPLIFIER

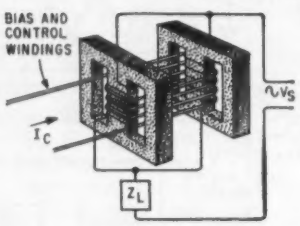


FIG. 1—Construction of the amplifier assembly

This saturable inductor assembly, together with its feedback rectifiers used in a magnetic amplifier, operates as an amplifier tube, the characteristics of which are under control of the designer.

The essential requirement of a thermionic tube to operate as an amplifier is a minimum voltage between anode and cathode, sufficient to maintain the electrostatic field.

The essential requirement for the inductor assembly to operate in the magnetic amplifier is a minimum current sufficient to maintain the magnetic field. This is why the current flowing in the output circuit of such an assembly can never be zero when it is in operation

THE BASIC EQUATIONS

Thermionic Tube	Magnetic Tube
$I_a = V_a G_a + G_m V_g$	$I_l = V_c K_l + (K_c I_c + K_b I_b)$
$G_m = \mu G_a = \partial I_a / \partial V_g$	$G_m = \partial I_l / \partial V_c = N_c / (1 - \beta) N_l R_c$
$M_v = -\mu R_l / (R_a + R_l)$	$M_c = V_l / R_l I_c$
$= -V_l / V_g$	$= V_l / V_{in}$
$M_i = I_a / I_g$	$M_i = I_l / I_c$
$M_p = I_l^2 R_l / I_g^2 R_g$	$M_p = I_l^2 R_l / I_c^2 R_c$

DEFINITIONS USED IN DESIGN EQUATIONS

A_c—Cross-sectional area, in cm², of the core material in a magnetic amplifier inductor

β—Current feedback factor due to use of rectifiers in a magnetic amplifier

G_a—Internal conductance of a thermionic tube, equal to $1/R_a$

G_m—Inherent gain of an amplifier, mutual conductance, transconductance or perveance

I_a—Output (anode, plate) current of a thermionic tube

I_l—Current flowing in the load circuit of a magnetic amplifier

I_o—Minimum value of current, magnetizing current, that may flow in the load circuit of a magnetic amplifier

K_b—The current gain factor of the bias winding, equal to N_b/N_l

K_c—The current gain factor of the control winding, equal to N_c/N_l

K_l—The internal conductance of a magnetic amplifier, to a close approximation, $1/\omega_s L$, corresponding with G_a in the thermionic tube

L—Inductance, in henries, of a magnetic amplifier inductor with no d-c polarization

l_i—Mean length of a magnetic path, in cm, in the core material of a magnetic amplifier inductor

M_i—Current gain of an amplifier

M_p—Power gain of an amplifier

M_v—Voltage gain of an amplifier

μ—The so called voltage amplification factor of a thermionic tube

μ_i—Magnetic permeability of the core material in a magnetic amplifier

N_b—Number of turns on the core of a magnetic amplifier inductor included in the bias circuit

N_c—Number of turns on the core of a magnetic amplifier inductor included in the control circuit

N_l—Number of turns on the core of a magnetic amplifier inductor included in the load circuit

R_a—Internal resistance of a tube

R_c—The total series resistance in the input circuit of a magnetic ampl.

R_c'—Shunting resistance or impedance across feedback rectifiers, also Z_c'

R_l—or Z_l—The resistance or impedance of the load into which the output is delivered

V_a—Supply voltage to a thermionic tube, d-c

V_g—Voltage applied at the grid of a thermionic tube as an information signal or for bias or gain control

V_l—Voltage appearing across the load in any amplifier

V_s—The power supply voltage, a-c, acting in the load circuit of a magnetic amplifier

ω_s—The angular frequency, $2\pi f$, of the supply frequency, V_s

Controls Transconductance

Useful form of magnetic amplifier for zero, d-c, or very low frequency currents can have many applications in control circuits or computers. This saturable reactor assembly has its analogy in the electron tube, and inherent gain is controlled by the total series resistance in the input circuit

of the electron stream between the anode and cathode, and increases the internal resistance, R_a. This has a two-fold effect upon the mutual conductance, $G_m = \mu/R_a$. Which of these two effects is the more important depends upon how the tube is loaded.

If $R_l \gg R_a$, the change in R_a is relatively unimportant, and μ is therefore the controlling factor. This is the case in the voltage amplifier.

If however $R \lessgtr R_a$, as in the case of the variable μ r-f pentode or tetrode, change in R_a becomes important, and G_m is then the controlling factor.

Variable G_m

Variable-μ is seldom used in an electron tube. Nevertheless, the title remains, partly because of prior usage, but mostly perhaps because the term variable-mu is easier said than the more correct term variable G_m, variable perveance or variable transconductance.

This brings us to the definition of optimum load. Optimum load may be for voltage amplification where $R_l \gg R_a$; current amplification with $R_l < R_a$; or power amplification with $R_l = R_a$, *at the peak value of* I_a. All of these are optimum loads for specific purposes.

Practical difficulties for G_m control arise in the use of the variable μ triode.

First, the gain-controlling signal must be applied in the same circuit as the information signal. This gives rise to the second difficulty, namely that the signal-handling capacity (available grid base) of the tube is reduced as the gain is reduced. This is awkward in circuits of the automatic-gain control type, where larger signal-handling capacity is required to deal with the larger signals encountered in the low-gain condition. However, G_m can be controlled by a source of voltage, V_c, independent of the signal voltage, V_g, with a so-called variable μ hexode tube.

Magnetic Amplifier

The magnetic amplifier, suitable for zero frequency, d-c, or very low frequency signals, is derived from the well known circuit shown in Fig. 2A.

A saturable reactor assembly is made by having two identical windings and cores connected in parallel so that the magnetic flux in the cores lies in opposite directions with respect to other windings which

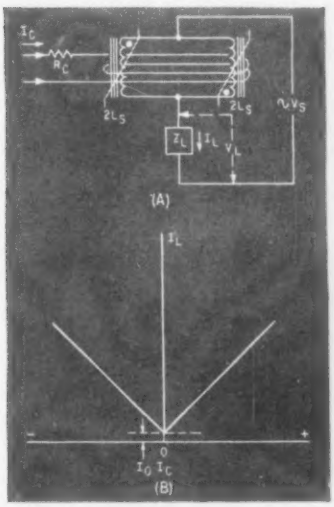


FIG. 2—Magnetic amplifier (A), with current characteristics (B)

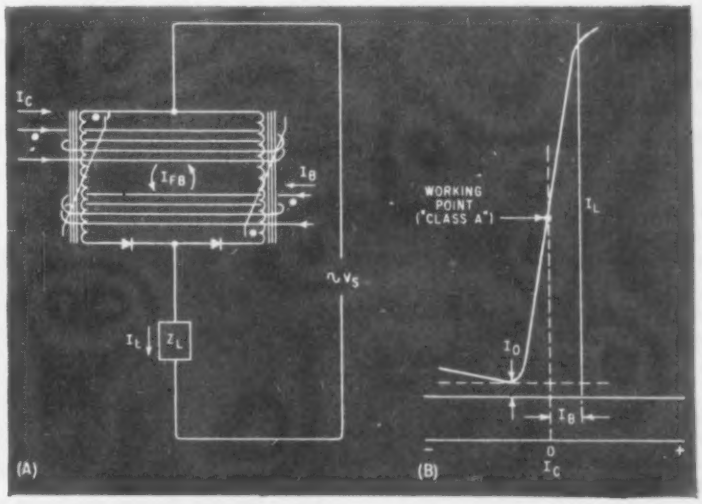


FIG. 3—Magnetic amplifier arranged with rectifiers to give positive feedback (A), and the characteristics obtained, (B)

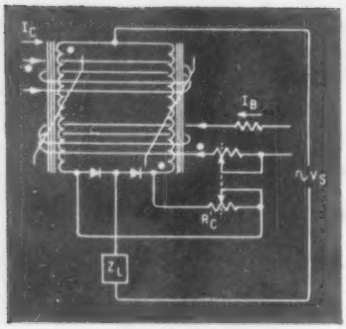


FIG. 4—Ganged manual control of bias and gain in magnetic amplifier

embrace both of the cores and their primary load windings. This arrangement balances the secondary windings, which would otherwise act as closed-circuited secondary windings and render the device inoperative.

If d-c is passed through any of the secondary windings, we get the input-current/output-current characteristic shown in Fig. 2B. Apart from the fact that the characteristic is symmetrical about the Y axis the action is somewhat analogous with that of a cathode follower and the current gain is low: $M_i = N_c/N_l$. Owing to the reduction in voltage across the reactor due to the voltage drop across the load resistance R_l, as I_l is increased, the degree of saturation is reduced, since this is decided by the ratio $(V_s - V_l)/N_l$. Consequently more I_c is required to produce a given value of I_l. A pair of rectifiers connected as shown in Fig. 3A solve this difficulty. A pulsating d-c (I_{rb}) proportional to the load current circulates around the closed loop formed by the load windings. This augments the effect of I_c when the latter is flowing in one direction, and opposes it when flowing in the other direction, so we get a form of positive feedback in the former case, and negative feedback in the latter case.

But since negative feedback already exists in the original circuit of Fig. 2, the primary interest is in the condition existing in the second case. The resulting output-current, input current characteristic is shown in Fig. 3B.

The slope of the I_l/I_c characteristic of one branch of the curve has been reduced and that of the other branch of the curve, increased in both cases by the feedback factor, β. In most practical assemblies of this kind, β lies between the limits 0.94 and 0.99. Its value depends upon the forward-reverse voltage/current characteristic of the rectifiers and the resistance of the load winding, N_l. Then the current gain on one branch of the characteristic is $N_c/N_l\ (1 - \beta)$ and on the other branch of the characteristic $N_c/N_l\ (1 + \beta)$. The value of I_o, provided it is not limited by a high value of R_l, is also increased by the factor $(1 - \beta)$, and the original value of I_o is shifted along the X axis to a value of $I_o \neq 0$.

Like a Triode

A striking resemblance to a triode L_o/V_g characteristic, is seen when substituting I_c for V_g. The greater the value of β, the closer this resemblance. This is so much so that this amplifier can be operated in modes analogous with Class A, Class B or Class C modes in the amplifier tube, providing only that a high value of β is obtained.

It turns out also that the optimum load for power amplification is that which makes $R_l = 1/K$ at the maximum rms value of I_l, another analogy with the amplifier tube.

If the feedback rectifiers are shunted with a variable resistance or impedance, the value of β, and therefore the current gain, can be controlled. Resulting characteristics show a close resemblance to those of the so called variable μ tube.

This is so if we substitute I_c for V_g. Then V_c, the input voltage, is $I_c R_c$, and since R_c is constant, the analogy is in fact an identity.

If we make $R_l >> 1/K$ we get a variable μ characteristic, and if we make $R_l \gtrless 1/K$ we get a variable G_m characteristic, as in the tube.

For the same reasons as in the case of the tube, it will seldom find use in the variable μ application.

Having noted the similarities between this amplifier and its tube counterpart, it is necessary also to note the differences.

Unlike a Triode

The control over μ or G_m is applied in an entirely separate circuit from that in which the information signals are applied. The working point on the characteristic can therefore be selected independently of the gain control. If the value of bias current is chosen suitably, the change in signal-handling capacity is increased with reduction in gain, Fig. 4. Also it is impossible to apply sufficient positive feedback to make the amplifier unstable; and application of feedback does not affect the input and output resistances of the amplifier.

A variable μ tube is often used as a multiplier, so that when $R_l < R_o$, the variable $-G_m$ condition is $I_l = G_m V_g$. Therefore if G_m is arranged to be controlled by a voltage V_c independent of the signal voltage V_g, we have a multiplier. This is not too difficult for a variable μ pentode, or better still, a hexode, as shown in Fig. 5A.

In the magnetic amplifier, G_m is controlled by R_c. Multiplication can be arranged with mechanical sliders, Fig. 5B, convenient for computer applications.

This device is also one way of making an electric cam, if the two potentiometers are connected mechanically and wound to predeter-

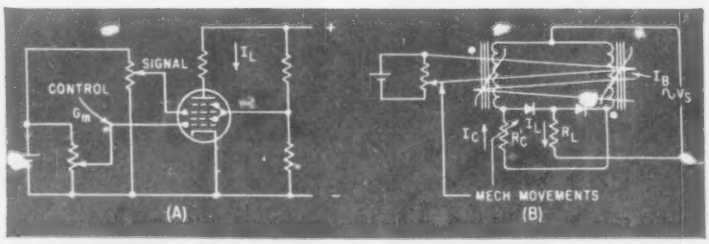


FIG. 5—Diagrams illustrate principle of transconductance control in a hexode tube (A), and in a magnetic amplifier (B). Potentiometers may be controlled by mechanical movements representing quantities to be multiplied

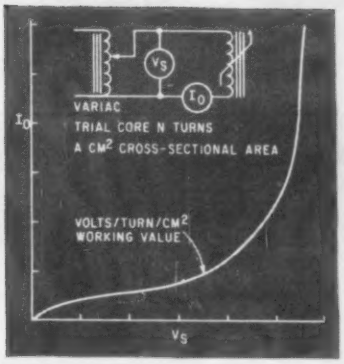


FIG. 6—Graph used to determine relevant characteristics on a trial core

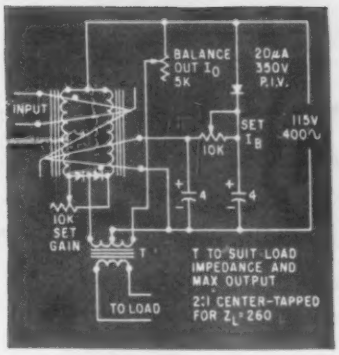


FIG. 7—Typical design for a 40-watt amplifier, with a 115-v 400-cycle supply

mined laws. Many variations of this application are possible.

Materials and Design

For the core, it is best to use a uniform, grain-oriented square hysteresis loop material, such as Orthonol, Deltamax, Permalloy, or H.C.R. The core material must be arranged so that unavoidable air gaps are kept to a minimum. For this reason, the toroidal clock-spring type of core is best, but special stampings are obtainable which are nearly as good.

The cross section of the core must be as nearly uniform as possible throughout, and if anisotropic materials, those listed above, are used, the grain must run in the direction of the field throughout. This is taken care of in the clock-spring type of core.

It is best to determine relevant characteristics experimentally, on a sample core, as shown in Fig. 6.

Having set the working point at a safe distance from where the V_s/I_e curve takes a sharp turn upwards, the working value of H is determined in terms of volts-per-turn-per-centimeter, (or inch)-squared of core cross-sectional area. In a series built by the writer, H.C.R. material was used, and the value obtained was 0.137 v/turn cm² at 400 cycles.

Core Equations

The relevant design equations are then shown to be

$$N_t = \frac{V_s}{0.137\,A_i} = \frac{V_s}{0.017\,A_i}$$

at 400 cycles at 50 cycles

$$\frac{Z_l}{N_t^2} = 0.0227\,\frac{A_i}{L_i} = 0.0283\,\frac{A_i}{l_i}$$

at 400 cycles at 50 cycles

$$I_e = 0.3\,\frac{l_i}{N_t} = 2.4\,\frac{l_i}{N_t}$$

at 400 cycles at 50 cycles

where A_i is the cross-sectional area of the core in cms²; and l_i is the mean length of the magnetic path in cm. A reasonable value for I_e is 5 percent of $I_{i\,max}$ rms. Z_l in the above equations is the optimum load impedance for power amplification ($= 1/K_i$ at $I_{i\,max}$) and is therefore intermediate between the values required for variable μ and variable G_m operation respectively.

At any given value of supply frequency, Z_l, N_t, V_s and A_i are all tied together, so that for a given core, one can choose either V_s or Z_l, but not both. However, this does not matter much if the application permits the use of an output transformer. Otherwise one must design for a specific value of Z_l and adjust the value of V_s accordingly.

For a reasonably linear output characteristic and high maximum gain, the maximum output is given by $P_{max} = 0.82\,V_i$, where $V_i = A_i l_i$, the net core-material volume in cm³.

An unexpected fact is that the power-handling capacity of a given core is not much affected by the supply frequency, because at maximum power output, the core is saturated and therefore not handling power. Gain and impedance levels are of course affected.

40-Watt Amplifier

For preliminary design, assume that β is 95 percent, then the current gain is $M_i = 20\,N_s/N_t$.

If $N_b = N_t$, the biasing current required to reduce I_t to I_e, and for Class A operation is one-half I_e. It is usually convenient to make $N_b < N_t$ and use a larger biasing current. Figure 7 is a typical design for a 40-watt amplifier working from a 115-v 400-cycle supply.

Design Specifications

Core details are as follows:

Special stampings, M.E.A. 524 of 0.006 H.C.R. Alloy, each core ⅝ in/⅝ in (145 laminations). A_i = 4.45 cm², l_i = 25.1 cms; V_s/N_t = 0.505; I_eN_t = 7.52; $Z_l/N_t^2 = 4 \times 10^{-3}$.

Load windings, each 388 turns, No. 24 S.W.G.; control winding, each 388 turns No. 28 S.W.G.; bias winding, each 388 turns, No. 28 S.W.G.; feedback rectifiers, selenium S.T.C. Type 1288.

At maximum gain and rated output, the characteristics are as follow: N_s/N_t (effective*) = 2; N_b/N_t (effective*) = 2; Z_l = 260 ohms; M_i = 29.4; M_s = 525; $M_p = 1.54 \times 10^4$ = 41.9 db; G_m = 2.02 A/V, β 94.4 percent; I_e = 20 ma; I_b (Class A) = 10 ma.

Physical size overall is 4 × 3.5 × 3 in; and weight is four pounds.

Owing to the use of selenium rectifiers, β is rather on the low side, and weight and bulk are greater than if germanium or silicon rectifiers were used.

It is somewhat difficult to give a figure for the maximum possible output, since in comparison with the tube amplifier, the overload capacity is enormous. For nonlinear operation and reduced maximum gain this amplifier can deal with a load of 200 V. A.

In this particular design, a gain reduction of about 15:1 is available. Consideration of the fundamental equations given will show how the performance may be modified to suit specific requirements.

Patents relating to this device are held by the Sperry Gyroscope Co., Ltd., England.

REFERENCE

(1) C. C. Whitehead, Variable μ Magnetic Amplifier, *Wireless World*, May, 1959.

* Owing to the fact that the single bias and control windings are wound over both cores, their effect is doubled.

Wire Shielding Values

Nomogram quickly finds shielding parameters. Percent coverage and wires per carrier calculated in sample problems

By **JOHN SELL**, Chief Project Engineer—Wire, Revere Corporation of America, Wallingford, Connecticut

IN TODAY'S ELECTRONIC circuits with their higher frequencies and higher power loads, shielded wires are playing an increasingly important role. Metallic shielding is usually applied to a wire in the form of a braid, shown in Fig. 1, in the same manner as the well-known cotton or glass yarn braids. While the formula used to compute shielding values is not complicated, its use is greatly simplified by using the nomogram in Fig. 2.

Since the line *CD* represents the axis of the wire, the angle formed between *CD* and the line drawn to *CE* is the actual angle that the braid makes with the wire. This permits the designer to see the results produced by using the parameters which he has chosen, and also to see the effect of changing one or more of the parameters. The formula used to develop the nomogram is found in MIL—W—16878 and is $K = 100\ (2F - F^2)$.

Where shields are applied to wires to obtain electrical properties and not for mechanical protection, they are generally fabricated of material which is considered a good conductor, such as tinned copper or silver-plated copper. The gage sizes in common use range from Awg 34 to 40. The small sizes are used on small wires to keep size and weight to a minimum and to obtain as much flexibility as possible. Where shields are applied for mechanical protection they are usually of type 302 or 304 stainless steel and range in size from Awg 30 to 36. In high temperature applications nickel clad copper shielding is coming into greater use.

If it is desired to have the shield push back and open up so that a terminating sleeve can be slid under it, then the angle of braid with the axis of the wire should be small; that is, 30 to 35 degrees. If it is desired to produce a braid that will not slide, a relatively large braid angle, 50 to 55 degrees, should be used. The most desirable angle from a production viewpoint is 45 ±10 degrees.

Table 1—Symbols

a	Angle of braid with cable axis
C	Number of carriers
D	Diameter in inches of wire under shield
d	Diameter in inches of individual wire
F	$NPd/\sin a$
K	Percent coverage
N	Number of wires per carrier
P	Picks per inch of wire length

$\text{Tan } a = 2\pi(D + 2d)P/C$

In addition to the angle of braid, other production factors must be considered, and the following values are recommended. First, as a compromise between ease of packaging and braiding speed, 3, 4 or 5 ends are recommended. Second, 36 gauge braiding material in the copper-type materials and 34 gauge in the stainless-type materials are recommended for most applications. Finally, most manufacturers will have 16 and 24-carrier machines available.

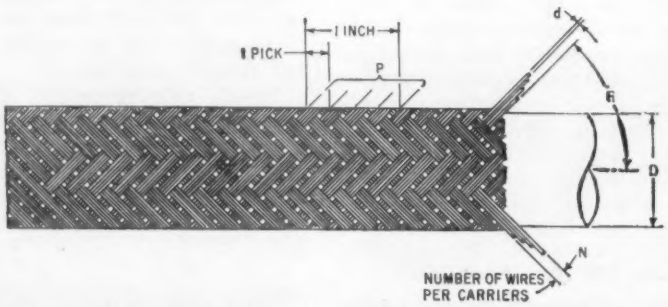


FIG. 1—Typical shielded wire has 4 picks per inch and 4 wires per carrier

Examples

The use of the nomogram depends upon the factors which are known and the results desired. In one case, the process engineer may start with the required coverage on the *JK* scale and the number of carriers on the available equipment on the *AB* scale and end up with the required number of picks per inch. In another case, the finished product may be available to the quality

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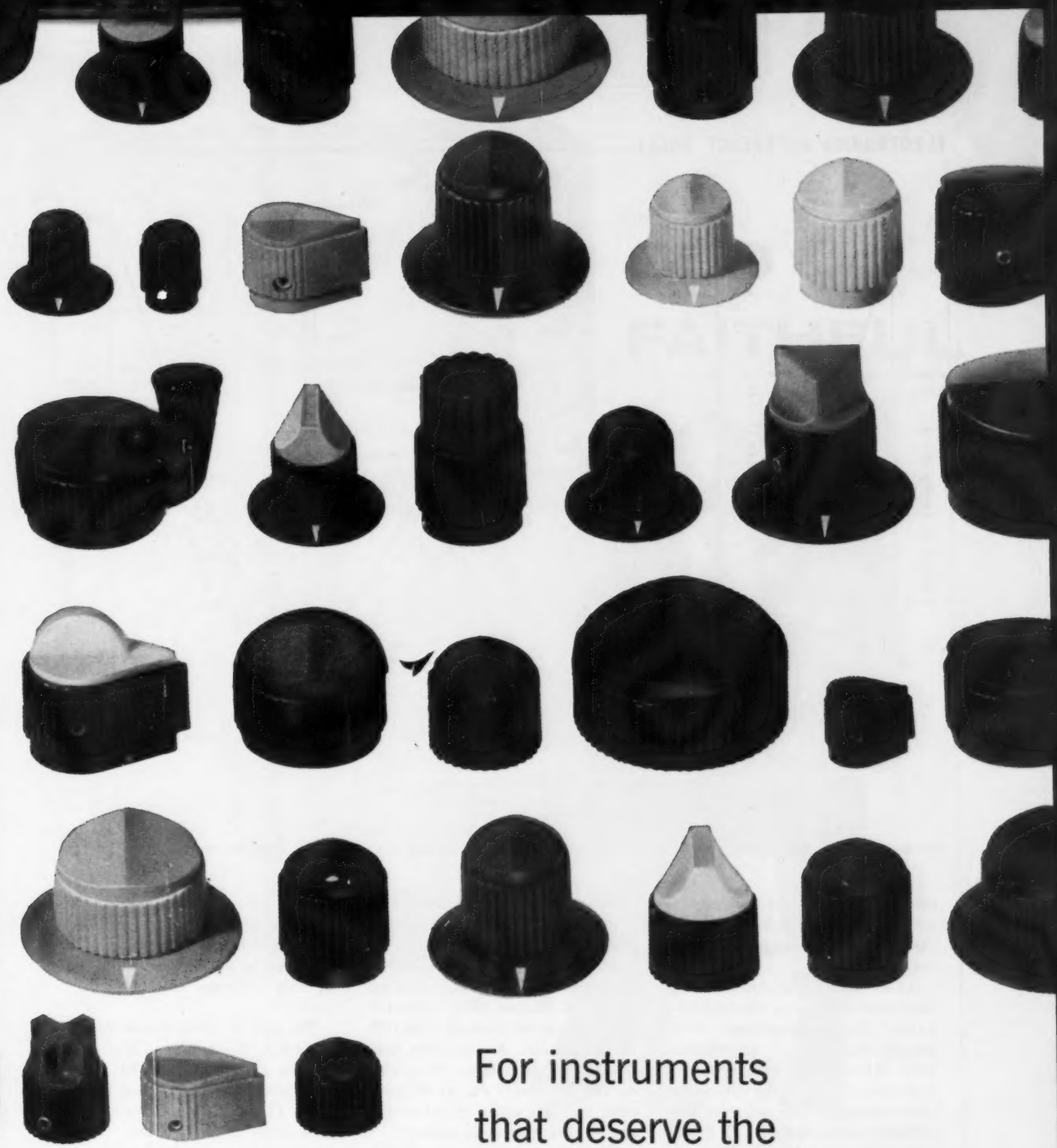

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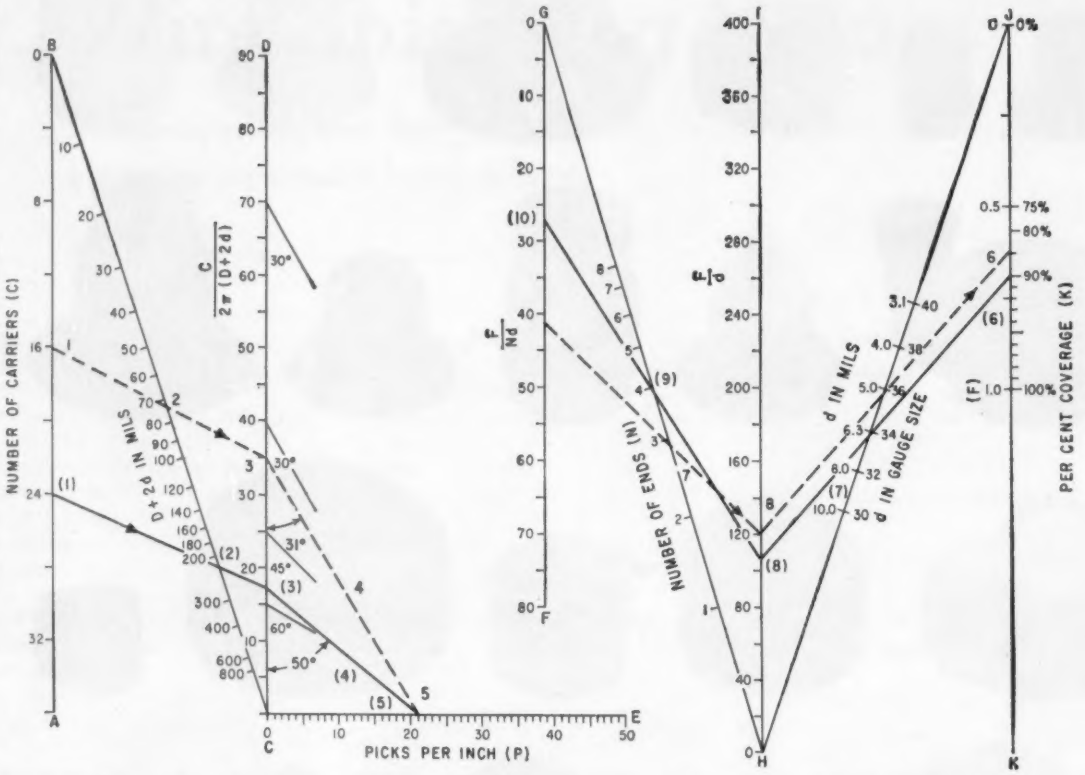


FIG. 2—Nomogram aids solution of wire shielding equation for percent coverage and number of wires per carrier

control inspector and the percent coverage may be determined by inserting the values as found on the wire.

As an example of finding percent coverage (K), a shielded 20-gauge Teflon insulated wire manufactured in accordance with MIL—W—16878, type E, is assumed to have the following measurements. The o.d. over the primary insulation (D) is 0.062 inches, the shielding wire o.d. (d) is 0.005 inches and the measured braid angle (a) is 31 degrees. Also, there are 16 carriers (C), 3 ends (N) and 21 picks (P).

To find K, first locate 16 on scale BA. Then locate $(D + 2d)$ in mils (62 + 10) on BC. The intersection on CD is then found to be 35. At 35 on CD a 31-degree angle is laid out, or, in this case since P is known, a line is drawn between 35 on CD and 21 on CE. The length of line between CE and CD is found to measure 41 units on CE. This length is measured off on GF, starting at G. A line is then extended from this point through 3 on GH to 123 on HI. A line from this point through 5 mils (36 gage) on HJ intersects JK at 85 percent, indicating the shield coverage on this wire is 85 percent.

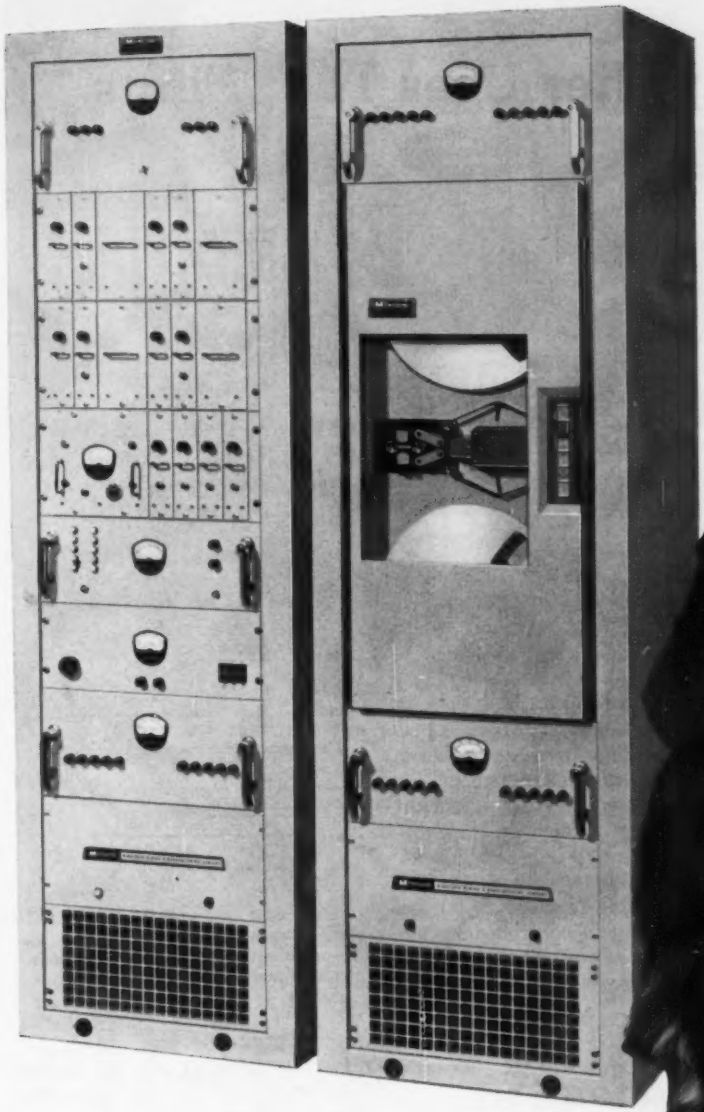
Checking this value by means of the formula, we find that $\tan a = 0.595$, and $a = 31$ degrees. For F, $3 \times 21 \times 0.005/0.511 = 0.615$ and $K = 100\ (1.23 - 0.378) = 82.5$ percent.

Wires Per Carrier

As an example of finding the number of wires per carrier, it is assumed the cable is to be armored with 34-gage stainless steel and that a 24-carrier braider is available. The o.d. over the primary insulation (D) is 0.209 inches, the shielding wire o.d. (d) is 0.0063 inch and the desired coverage (K) is 90 percent.

To find N, first locate 24 on scale BA. Then locate $(D + 2d)$ in mils (209 + 13) on BC. The intersection on CD is then found to be 17. At 17 on CD a 50-degree angle is constructed. (This angle was chosen to produce a nonslip braid.)

Next 20.5 picks per inch is found on CE. The length of line between CE and CD is then found to be 27. Starting with 90 percent on JK and extending a line through 34 gauge on HJ, point 108 is found on HI. A line is then drawn from 108 on HI to 27 on GF. The number of wires per carrier is found to be 4 on GH.



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Parametric Amplifier Uses Thin Films

RECENT development of practical nonlinear low-loss reactance elements has sparked increasing interest in parametric amplification. Most elements have been capacitive using the transition region in back-biased junction diodes. Only limited consideration has been given to inductive elements, and then mostly to elements containing ferrites.

A. A. Read and A. V. Pohm of the Electrical Engineering Department and Engineering Experiment Station of Iowa State University of Science and Technology have used inductive elements made from thin ferromagnetic films similar to those being used for computer memories. An experimental parametric amplifier has been constructed. Signal gains of about 20 db have been obtained as well as superregenerative detection of very low level signals. The work, partly supported by a National Science Foundation grant, was described at the National Electronics Conference.

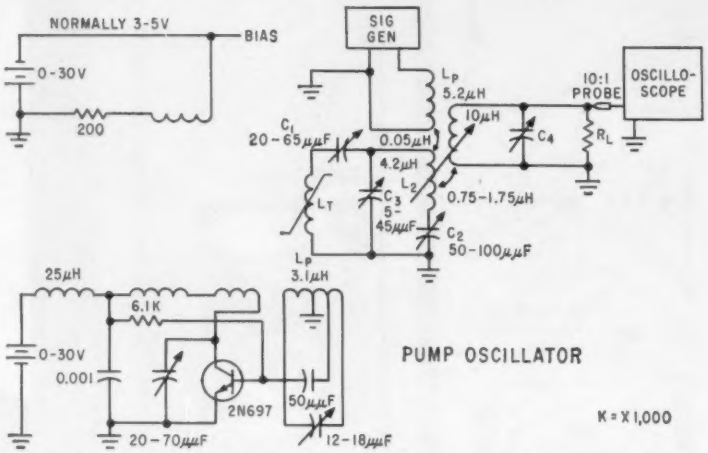

FIG. 1—Exploratory low-frequency parametric amplifier uses thin ferromagnetic film inductive element

Parametric Amplifier

A 6,000 angstrom permalloy film was used to make the element. Since the exploratory attempts were made with a limited number of films, circuits are not optimum with regard to arrangement or results.

A pump frequency from 24 to 28 mc and signal frequencies from 8 to 12 mc were chosen to permit direct recording of r-f output without intervening demodulation devices.

The transistor oscillator in Fig. 1 is adjustable from 20 to 30 mc. Its r-f output is controlled by adjusting d-c power supply voltage. The signal winding consists of about 40 turns of No. 40 enamel wire wound around the permalloy film-glass substrate core as in Fig. 2. The pump winding has about 30 turns of No. 28 enamel wire to form a rectangular coil.

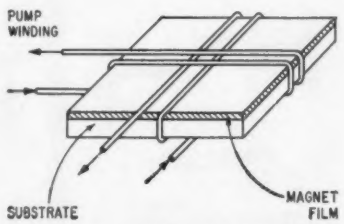

FIG. 2—Representation of thin-film inductor shows pump winding perpendicular to signal winding

The signal winding is perpendicular to the pump winding. The bias winding is parallel to the pump winding on a form that keeps the two windings separated at least ¼ in. to minimize stray capacitance of the pump winding. Figure 3 shows the signal winding inductance as a function of d-c bias I_b in the bias winding and of I_s in the pump winding. Gain and bandwidth as functions of d-c power input to the pump oscillator are shown in Fig. 4. Center of the sweep is 9.5 mc.

Rough measurements indicated that about 25 percent of the d-c in-

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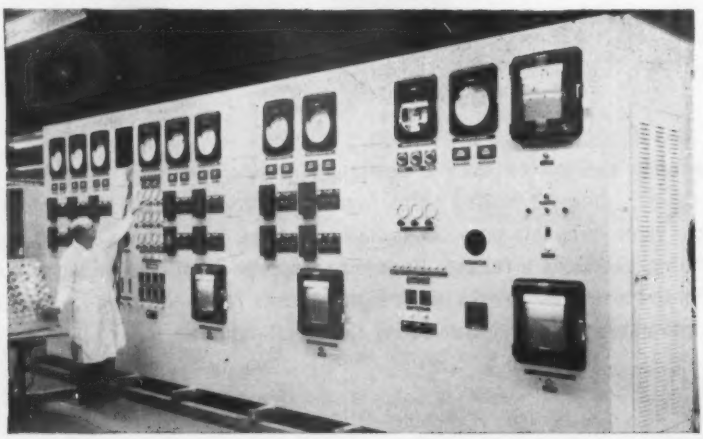

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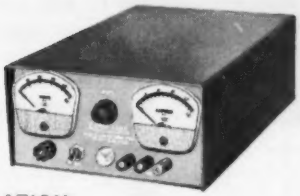

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DUAL OUTPUT	0-32	0-1.5
SC-32-2.5	0-32	0-2.5
SC-32-5	0-32	0-5
SC-32-10	0-32	0-10
SC-32-15	0-32	0-15
SC-60-2	0-60	0-2
SC-60-5	0-60	0-5
2SC-100-0.2	0-100	0-0.2
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SC-300-1	0-300	0-1

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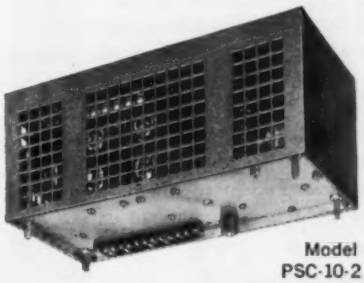

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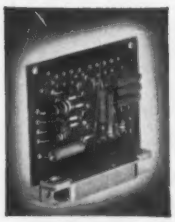

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put power to the pump oscillator was actually lost in the pump winding. Of this amount, very little was actually film loss since complete removal of the transverse inductor had very little effect on magnitude of pump voltage. The low-level Q of the pump tank was measured by the resonance-curve method to be about 30.

To obtain larger bandwidth, C_3 was shorted out and C_4, C_2 and the mutual inductance of the transformer adjusted to give a response typical of an over-coupled i-f stage. Next, C_1 and C_3 were adjusted to give a response with pump power applied and with a bias current of 20 ma. Gain was 16.1 db, and bandwidth was 130 kc. A decrease in bias current changed average value of signal winding inductance and thus tuning, resulting in responses at 15 ma of 11.8 db gain and 195 kc bandwidth. At 10 ma, gain was 6.9 db and bandwidth was 286 kc.

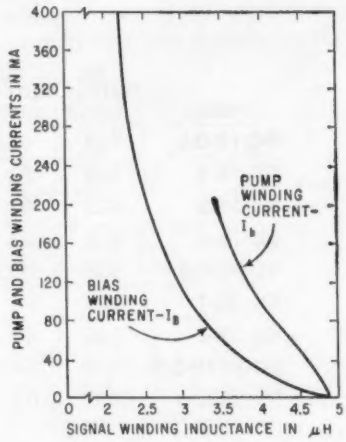

FIG. 3—Signal winding inductance is plotted as function of currents

Investigators [1, 2] have reported extremely high gains using parametric amplifiers as superregenerative detectors. Operation of the two-frequency amplifier described was compared as a conventional parametric amplifier and a superregenerative amplifier. A 500-cps, 100-percent modulated, 10-mc output signal was obtained with pump power off. When sufficient pump power was applied so that the system was just short of oscillation, output increased by about 22 db. When power supply voltage to the

pump oscillator was varied, output varied. Pump power supply voltage was then adjusted for maximum pump oscillator output, and the signal circuit was oscillatory. At minimum pump output, the signal circuit was damped.

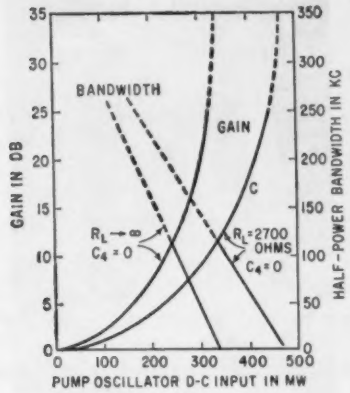

FIG. 4—Gain and bandwidth are shown as functions of d-c power input to pump

When the signal circuit changes from being damped to being oscillatory, the oscillations increase from whatever initial conditions are present in the circuit at that time. If initial signal conditions are large, final amplitude reached after a fixed time is relatively larger than final amplitude reached when initial signal conditions are small. Within given limits the final signal is essentially a constant times the output.

In circuit operation of this type, amplitude gain of several thousandfold can be obtained. In one case, pulse amplitude represented a gain of about 66 db or a factor of 2,000 over output with the pump off.

Higher Frequencies

The experimental thin permalloy film parametric amplifier which was constructed and operated in the 10 to 15-mc region was analyzed on the basis of a lossless quasistatic model. To analyze thin-film parametric amplification at much higher frequencies, the losses in the magnetic material resulting from spin relaxation losses must be included.

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(1) B. B. Bossard, Superregenerative Reactance Amplifier, *Proc IRE*, **47**, p 1269, July 1959.

(2) J. J. Younger, A. G. Little, H. Heffner and G. Wade, Parametric Amplifiers in Superregenerative Detectors, *Proc IRE*, **47**, p 1271, July 1959.

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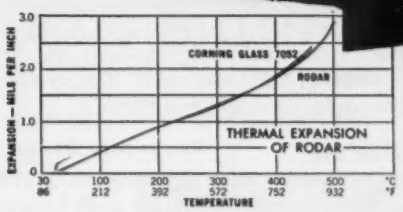


Another Special Alloy for a Specific Purpose

This precision alloy was developed for sealing metal to hard glass. Wilbur B. Driver Rodar is processed from melting to finished size in our own plant under the strictest controls to insure consistent analysis, temper, uniform grain size and conformance to customers' specifications. The superior stamping and sealing properties of Rodar make it *the preferred sealing alloy.*

Rodar produces a permanent, vacuum-tight seal with simple oxidation procedure and resists attack by mercury. Readily machined and fabricated, Rodar can be welded, soldered or brazed. Available in wire, strip and bar to your specifications.

PROPERTIES

Composition (Nominal)
Nickel 29%
Cobalt 17%
Manganese 30%
Iron . . . . . Balance
Melting Point
. . 1450°C. (Approx.)
Specific Gravity. . 8.36
Weight Per Cubic Inch
. . . . . .302 lb.
Electrical Resistivity
. . . 294 Ohms C.M.F.
Tensile Strength
. . . . . 80,000 PSI
Hardness
. . . . 82 B Rockwell
Elongation
30% (2" gauge length)

Temperature Range	Average Thermal Expansion, *Cm/Cm/°Cx10-6
30° To 200 C.	4.33 To 5.30
30° To 300 C.	4.41 To 5.17
30° To 400 C.	4.54 To 5.08
30° To 450 C.	5.03 To 5.37
30° To 500 C.	5.71 To 6.21

*As determined from cooling curves, after annealing in hydrogen for one hour at 900°C. and for 15 minutes at 1100°C.

CIRCLE 95 ON READER SERVICE CARD 95

Small Packs for Regulated High Voltage

RECENTLY DEVELOPED components, used in miniaturized high-voltage sources, are now used most effectively to reduce weight, increase efficiency and provide practically infinite life service.

This week ELECTRONICS has learned some interesting details about the component design of precision regulated high-voltage power packs that are planned as part of satellite instrumentation, infrared detection systems, instrumentation developed for underwater sound detection, and compact high power for nuclear instrumentation.

During the past few weeks, attention has been drawn to these neatly packed precision power units because of their use in radiation hazard detection instrumentation on the ground, and advanced counters designed to reach 2,000 miles up in space.

Project Javelin, set to probe the Van Allen radiation belt, will uncover data on the atomic content of this belt, with the 7 oz power pack essentially the same as that shown in Fig. 1. The unit was developed by Components Corporation, Denville, New Jersey.

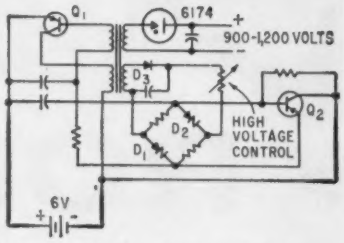
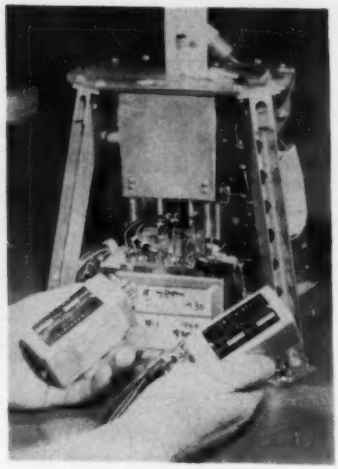


FIG. 1—Schematic circuit used in transistorized high voltage power pack. The unit is potted in an aluminum can equipped with a mica filled, molded octal plug



Fifteen-pound package of Lockheed-designed telemetering equipment for Project Javelin includes precision regulated high voltage components, foreground, [illegible] capable of maintaining 900 to [illegible] volts to a small fraction of one percent for normal battery and load variations

Component Design

The interesting thing about this pack is that you don't have to throw away a lot of power to do the job of controlling flux before any amount of power is dissipated.

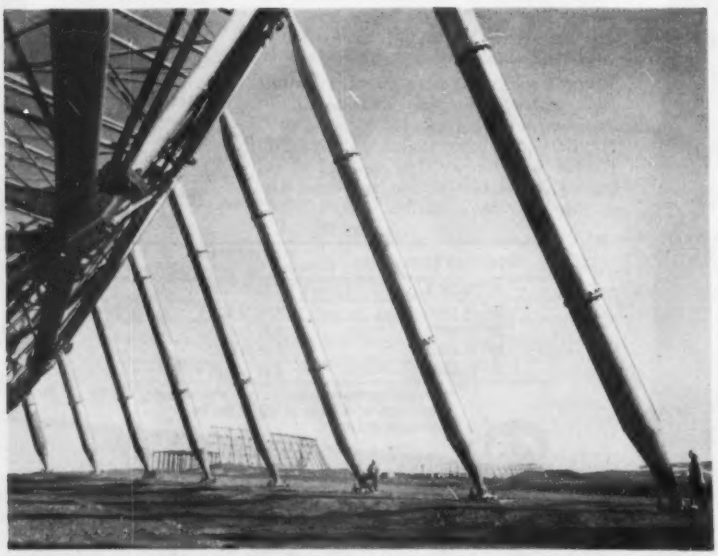
Basic to the design is the use of a blocking oscillator type of voltage step up. Here a tightly coupled oscillator is operated with a large time constant in its bias or amplitude control circuit. A medium power transistor is used in conjunction with a ferrite core oscillator transformer to reduce hysteresis and eddy current losses to a minimum. A relatively high self resonant frequency of 3,500 cps, is used to minimize weight.

When an external rheostat is varied from 20,000 ohms to a few thousand ohms, the output will vary from approximately 1,200 to 900 v. Once this voltage is set, it will remain quite stable with respect to input and output load variations.

Another interesting thing to note is the use of a point plane rectifier, EIA No. 6174. This high voltage rectifier is operated at less than 10 percent of its normal rated current and less than 50 percent of its inverse peak voltage for practically unlimited life. Unlike a solid state rectifier, this cold cathode rectifier will operate at elevated temperatures as high as 85 C at reduced maximum power output.

Regulation is accomplished by the closed loop servo action of the zener bridge reference potential formed by D_1 and D_2 which is supplied by

Holding Radar Antenna Rigid



These giant stays are designed to hold a Ballistic Missile Early Warning System (BMEWS) antenna system rigid against 185 mph Arctic winds. Standing as high as a football field turned on end, the radar antenna will detect missiles at 3,000 mi range

Designed for M Application

MAGNETIC SHIELDS

Illustrated are a few of the stock mumetal or nicaloy magnetic shields for multiplier photo tubes and cathode ray tubes. Stock shields are available for all popular tubes. Custom designed shields are made for special applications.

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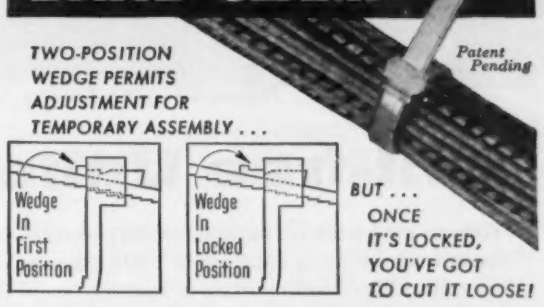
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CIRCLE 97 ON READER SERVICE CARD

a separate sampling winding and rectifier D_3. The differential output of this bridge is amplified by Q_2 and controls the bias on the power transistor Q_1.

Like any closed loop servo system, care must be taken not to apply highly reactive loads if stability is to be maintained. For example, if a large external filter to reduce the ripple (about one-half percent peak-to-peak) is used, a slight hunting may be noticed at the lower output voltage settings or at no load. This can be corrected by using an isolation or lag resistor in series with the external filter capacitor. If a 0.05 μf external capacitor and 250 k ohm filter resistor are added, the ripple will be reduced to less than 0.02 percent peak-to-peak. A minimum current drain of ten microamps is desirable to assure good regulation of this unit.

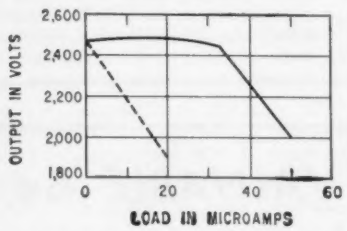


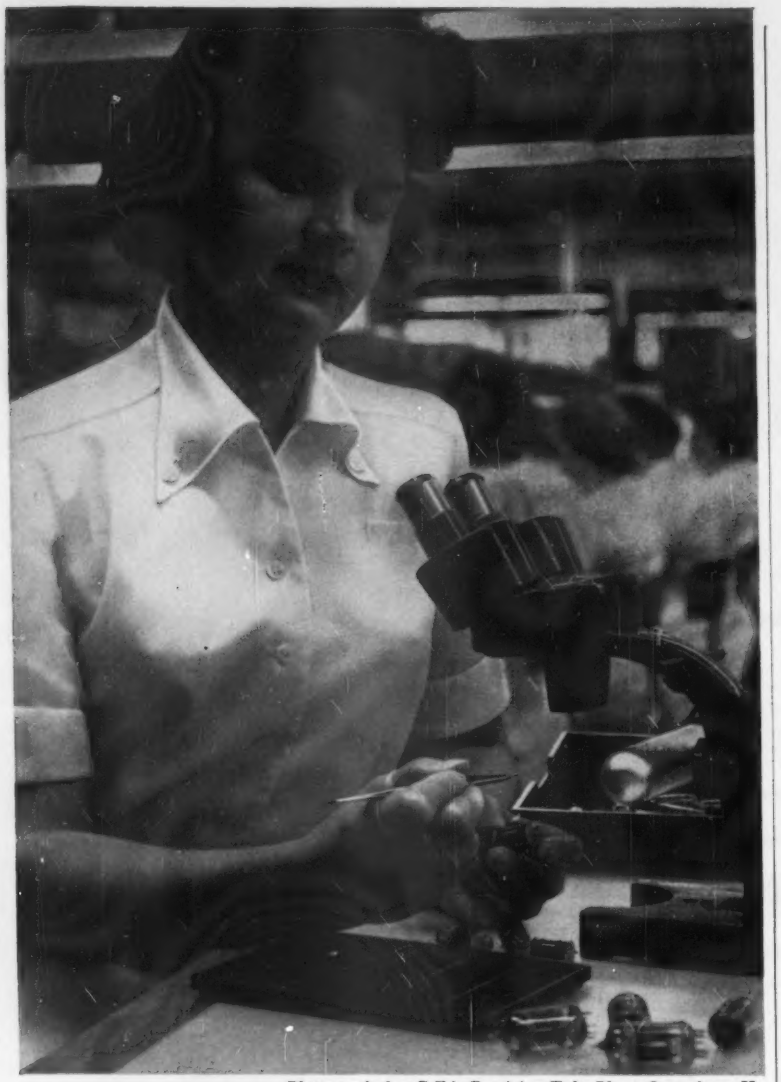
FIG. 2—Curves illustrate load regulation available from an experimental voltage doubler unit recently developed

It is possible to modify the internal time constants of the closed loop servo for operation at very low current drains, but the use of a large external filter and insufficient bleeder results in slow response—there is nothing to discharge the capacitor quickly.

Special temperature-compensated units have been supplied for critical applications.

Higher Voltage

An experimental voltage doubler circuit has been built and the curves, Fig. 2, illustrate the load regulation available at 2,500 v. The dotted curves are for an unregulated supply, while the solid curves are for the regulated doubler supply. The maximum voltage available from this supply exceeded 4,000 v. Of course at this high a voltage, less current is available because of



Photographed at G.E.'s Receiving Tube Plant, Owensboro, Ky.

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the limit in power handling capacity.

Jerry B. Minter, president of Components, Corp., says that they are now working with Du Mont on a completely packaged photomultiplier tube with no exposed high voltage that would eliminate the leakage problem at the base.

With normal temperature ranges and moderate changes in load, these miniature high voltage sources can easily maintain 0.1 percent regulation. Precision infrared detection systems have utilized these characteristics successfully. The power units will withstand pressure and have been used in oil well loggers.

The units are potted with a moderate temperature melting wax and will take considerable vibration without breakdown.

These regulated high-voltage power packs will be used in Lockheed instrument pods that will be shot 2,000 mi up at the National Aeronautics and Space Administration's Wallops Island Station in Virginia.

Casting Components In Ceramic Shell

A NEW METHOD of casting metal in a shell, with a ceramic mixture which will permit faster casting and lower cost for electronic components is claimed by Mercast Corporation of LaVerne, California.

Where a mass of ceramic matter has had to be applied to a wax pattern in the past, the new method permits the use of a relatively thin ceramic shell. The ceramic shell method supplements the frozen mercury process in fabricating complicated or large castings. Called Ceramercast, the method is claimed to combine the best techniques of both the lost-wax and frozen mercury processes and permit the casting of configurations too large and too complicated for lost-wax molds. It also assures important metallurgical properties to castings.

Mercast introduced the frozen mercury process in 1947 on a production basis, and besides its own plant in LaVerne has licensees in eastern United States and Great Britain, using this patented method for precision casting.

AN economical application of Digital's 5-megacycle, transistorized "building blocks" is this Magnetic Core Tester, which meets the need for an all-purpose test installation priced to fit the average laboratory budget.

Although it offers such refinements as control over pulse width, frequency and amplitude, the complete Tester consists of just eight Digital Test Equipment units, three current drivers and four power supplies costing less than $3000 in all. Assembled quickly and easily by means of handy patchcord interconnections, the components combine to perform the operations diagrammed above.

One key advantage of the Tester is that the components, like all DEC Building Blocks, can be utilized in other test and logical design applications whenever they are not needed for core testing. This makes the unit a particularly attractive investment for the buyer who wants the most for his money.

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CIRCLE 99 ON READER SERVICE CARD

Multiple Dip-Brazing for Assembly

MULTIPLE DIP-BRAZING can be used to assemble components when the size of the assembly or the number of its parts make it impractical to braze in a single dip. Assemblies can be returned to the molten salt bath as many as 4 times under adequately-controlled conditions.

Multidipping is being used by John Gombos Co., Clifton, N. J., to produce such assemblies as the radar equipment housing shown. It is made of a high-melting-point aluminum alloy with sheet thicknesses ranging from 0.020 inch to $\frac{5}{16}$ inch.

General dipping procedure is similar to that reported previously (Electronics, p 196, March 14, 1958). However, fixtures are not used. The parts are fastened together before dipping, with self-tapping screws. Screw heads are removed from the final assembly, leaving a flush surface. The brazing alloy, when liquid, fills the screw threads.

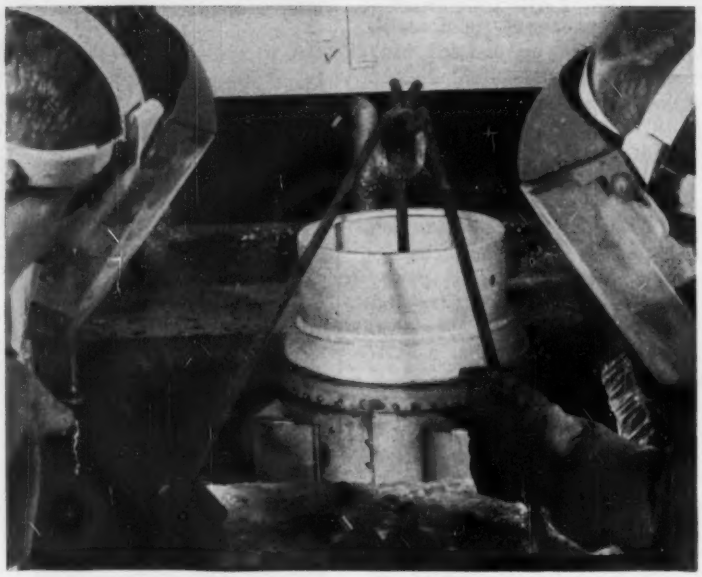
Seams brazed during the preliminary dips are brushed with wetted braze powder before the final dip. This provides a concentration of brazing alloy in the flux immediately around the seam so that any filler which might be lost is replaced. Parts are assembled in an order that permits the seams to be reached before final assembly.

The housing has an inner case built up of a tube, dome and flange; a corrugated wrap through which cooling air circulates; and an outer case which guides the coolant and serves as a mount for support structures (Fig. 1). The outer case is made up of a tube, dome and collar, and has an overall height of about $2\frac{1}{2}$ feet.

When the dome and collar are brazed to the outer case, the subassembly is dipped in an inverted position. This is necessary because the furnace, although the largest standard model, is not deep enough to take the full assembly. All sludge is cleaned from the bottom of the furnace, to prevent its corroding the aluminum.

For final assembly, the corrugation is wrapped around the inner case and the outer case, the brackets are fastened in place with screws, and the assembly is dipped to the middle of the dome.

All seams are made with brazing alloy in the form of shims which are positioned between parts, except for the collar and flange which are brazed with wire rings. The corrugations are fully brazed to the



Completed housing emerges from molten salt bath furnace. Top of the housing was brazed in a preliminary step

These parts are brazed together to form housing

Complete assembly. Screw heads have been removed to leave flush surface

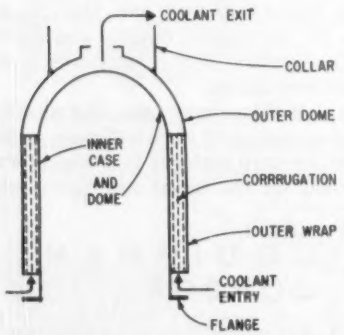


FIG. 1—Cross section of housing, locating main parts

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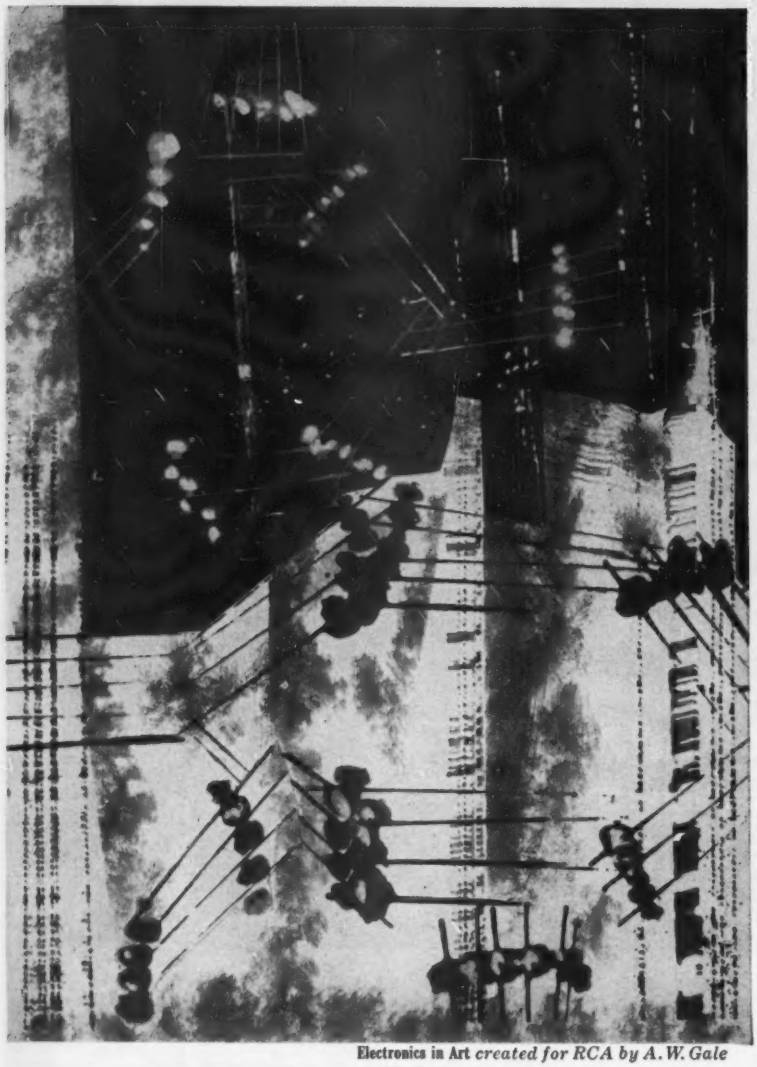

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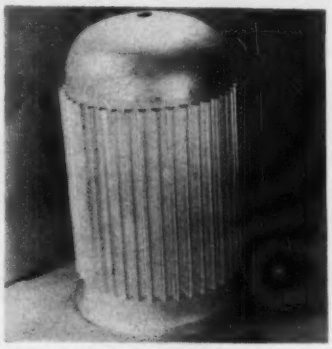
inner case and outer wrap.

Since the inner case is to be sealed and gas-filled, it is pressure tested at 30 psi. Two tests are made, one after subassembly and another after final assembly. A seal will be made via the flange and the small hole in the dome will be welded shut.

Process tests have shown, Gombos reports, that temperature control and cleanliness are critical in this method of brazing, to prevent seam failure.



Corrugated wrap around inner case, before brazing

Two independent temperature controllers are used, one monitoring the other. The bath temperature is held, for the housing, at 1,100 F,+5,−0, which is 25 degrees below the melting point of the housing material. Parts are degreased and chemically cleaned. After cleaning, assemblers may handle the parts only with clean gloves. Temperature controls, cleaning equipment and furnace are each in separate rooms.

Shaving Mirror Makes Dial Setting Easier

MAGNIFYING SHAVING mirror is used at Control Instrument Co., Brooklyn, N. Y., a subsidiary of Burroughs Corp., to simplify the setting of a business machine assembly dial. The setup (Fig. 1) solves problems caused by the dial's small size and its position.

Calibrations on the dial are difficult to align with a reference because the lines are wide compared with the gap between lines. Other setting operations are performed

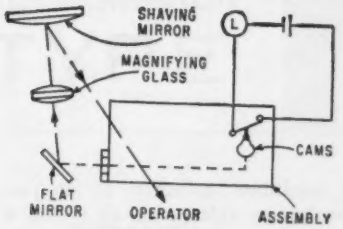
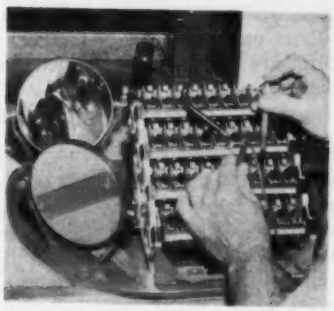


FIG. 1—Setup enables operator to view dial while adjusting cams



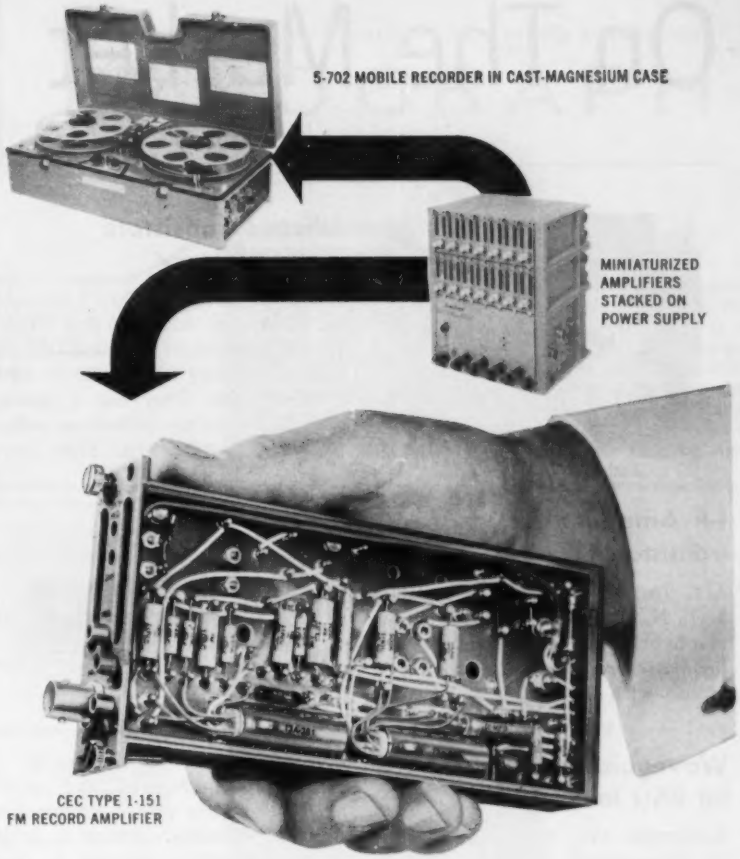
Magnified image of dial is seen in shaving mirror

from in front of the assembly and it would be awkward for the operator to view the dial directly.

The shaving mirror doubles the size of the image. A magnifying glass can be screwed between the mirrors for greater magnification, or the operator can wear a jeweler's eyepiece for very fine work. The assembly is held in place on an aluminum plate. Mirrors and magnifying glass are provided with threaded stud holders which screw into tapped holes in the base, preventing shifting of position.

Cam Timing

Setting the assembly shown also involves cam timing. The fixture is fitted with a red cam timing light. This assembly consists of thirty-six cams fitted onto four shafts, which are rotated through a gear train. Each cam actuates a set of breaker points similar to those used for automotive ignition. The cam dwell must coincide with a given setting on the dial. The position lead to the timing light is switched through the breaker points, thus indicating the make and break positions of the cam when the gear train is rotated. Each cam is then set-screwed in position and the next cam is ready for timing by merely attaching the timing light leads.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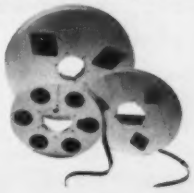

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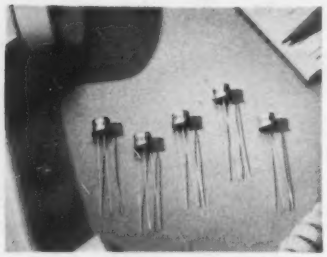
On The Market



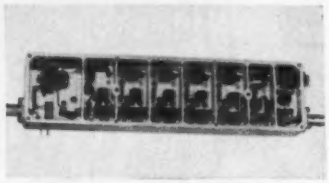
Silicon Transistors high frequency

GENERAL ELECTRIC CO., Liverpool, N. Y. A new series of five silicon triode transistors are capable of dissipating 500 mw at 25 C with no heat sink. They use a special crystal mounting technique called fixed-bed construction. They have a minimum collector to emitter breakdown voltage of 45 v and a minimum emitter to base breakdown voltage of 4 v. Typically the alpha cut-off frequency rating ranges from 10 mc on the 2N332A to 15 mc on the 2N336A. The transistors are hermetically sealed in welded cases.

CIRCLE 301 ON READER SERVICE CARD

I-F Amplifier transistorized

LEL, INC., 380 Oak St., Copiague, L. I., N. Y. The IF-83 i-f amplifier is a hybrid unit which combines the low-noise properties of a tube input circuit with the low-power requirements and ruggedness of transistors. A type 7077 subminiature ceramic triode followed by 5 silicon tetrode transistors provides a unit capable of withstanding high shock and vibration. Noise figure is better than 2.5 db.

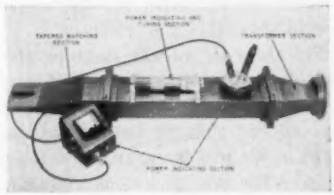


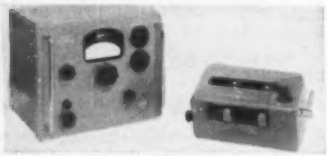
CIRCLE 302 ON READER SERVICE CARD

Waveguide Assemblies for R&D labs

RAYTHEON CO., 95 South Bedford St., Manchester, N. H., announces new waveguide assemblies for use with the PGM-100 and PGM-101 microwave power generators. These accessories now make possible a completely engineered and packaged microwave power system for R&D laboratories working in fields of gas excitation relating to free radical production, photochemistry and spectroscopy.

CIRCLE 303 ON READER SERVICE CARD





Capacitance Bridge high-range

ELECTRONIC APPLICATIONS, INC. 194 Richmond Hill Ave., Stamford, Conn. Model 543 high capacitance electrolytic bridge reads capacity and dissipation factor of electrolytic capacitors up to 100,000 microfarads. Measurements at 60 and 120 cycles. Unit features direct reading dials and a functional switch box.

CIRCLE 304 ON READER SERVICE CARD

Lamp Shields all-metal

AMATOM ELECTRONIC HARDWARE CO., INC., 88 Drake Ave., New Rochelle, N. Y. Two lamp shields for the T-3¼ lamp used in pilot lights and other instrument lighting are in production. They are of spring-type brass, cadmium plated, and fit directly on the glass portion of the T-3¼ lamp. They come in two stlyes, straight and flared.

CIRCLE 305 ON READER SERVICE CARD

Microwave Wattmeter battery powered

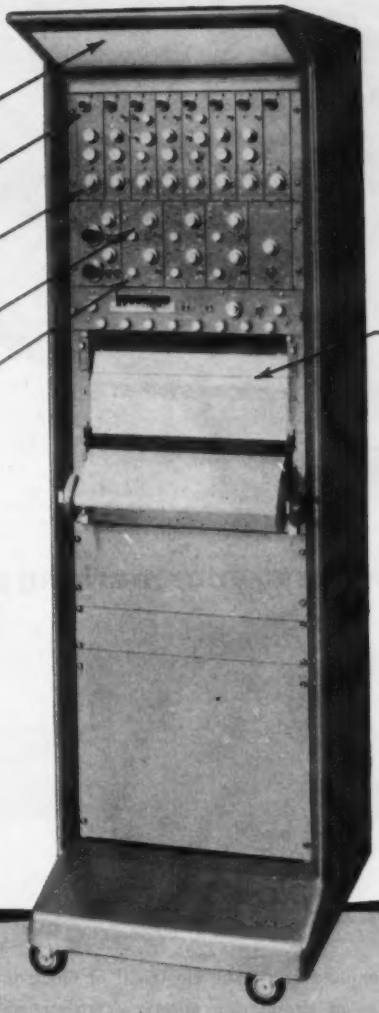
RADAR MEASUREMENTS CORP., 190 Duffy Ave., Hicksville, L. I., N. Y. Model 1300 microwave wattmeter is designed for field or lab power measurements in the 10 mc to 10,250 mc range. Unit is powered by a mercury cell battery and provides power measurement ranges of 0-1 mw and 0-10 mw, or −10 to 0 dbm and 0 to 10 dbm. Measurements over additional ranges are accomplished readily through the use of the company's series of type N

CIRCLE 105 ON READER SERVICE CARD→

OFFNER
ALL TRANSISTOR

TYPE R DYNOGRAPH

the most versatile . . . most sensitive direct writing unit available



Illuminated canopy

Type 9800 series input couplers provide all input, control and balance functions. Input available both front and rear.

Type 481 Preamplifier provides sensitivities from one microvolt to 5 volts per mm.

Type 482 power amplifiers—may be used without preamplifiers for up to 10 mv/cm sensitivity

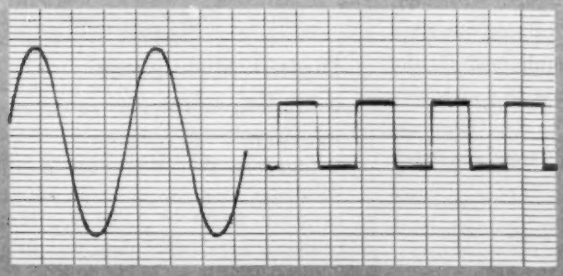
Zero suppression control

504-A paper drive—speeds from 1 to 250 mm/sec. Electrical speed shift 1 to 250 mm per minute available. Zero weave high precision drive, 850 ft. capacity (heat or electric) 1500 ft. (ink). Front loading, with full unobstructed record visible from front.

Combining all these features...

- *stable d-c sensitivity of one microvolt per mm*
- *true differential input*
- *high input impedance*
- *response to beyond 150 cps.*
- *reluctance, differential transformer, strain gage with a-c or d-c excitation, thermocouples, etc., used with all preamplifiers*
- *deflection time less than 1.5 milliseconds (2.5 ms with preamplifiers)*
- *fixed precision calibration*
- *instant warm-up*
- *precision source for d-c and 400 cycle excitation, self-contained*
- *zero suppression, twenty times full scale, both directions*

FULL SCALE, UNRETOUCHED CHARTS PRODUCED ON THE TYPE R DYNOGRAPH



EXTREME SENSITIVITY

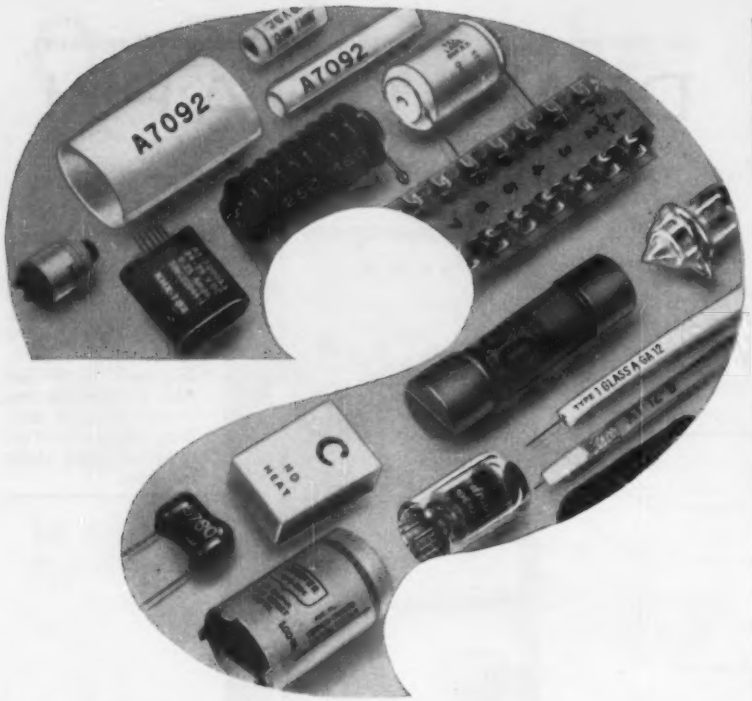
10 Microvolt RMS Sine Wave — **Ten Microvolt D-C Square Wave**

Four recording media. Heat or electric rectilinear—ink or electric curvilinear. Readily convertible.

All these features . . . plus 8 channels in only 35″ of rack space. Whatever your application for direct writing records . . . you should investigate the ability of the Offner Type R Dynograph to do the job *better* and more *simply*. Using transistor circuits* developed and tested for over three years in thousands of channels of Offner equipment, the Type R Dynograph has already proved its superiority in practically every respect to *any other* direct writing oscillograph. Write on your company letterhead for literature giving details and specifications.

**Patents granted and pending*

OFFNER ELECTRONICS INC.
3906 River Road, Schiller Park, Ill.
(Suburb of Chicago)



practical answers to your marking problems

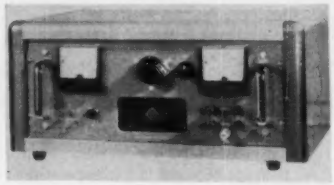
This 12-page booklet explains how the electrical or electronic product *you* make can be marked — at production speeds — with clear imprints that hold. Are you looking for a way to mark odd shapes — a *practical* short-run marking method — an ink that will hold on an unusual surface, or withstand temperature, handling, moisture or other conditions? This catalog describes machines, printing elements and inks that will meet *your* requirements in the marking of products ranging from subminiature components to panels and chassis. There are special sections with practical answers to color banding, Underwriters' Laboratories manifest label legend marking, tape and label printing, wire and tube marking, efficient "in-line" marking. For your copy of the Markem Electrical Catalog, write Markem Machine Co., Electrical Division, Keene 5, New Hampshire.

MARKEM

EVERYTHING INDUSTRY NEEDS . . . FOR PROFITABLE MARKING . . . SINCE 1911

couplers and attenuators as auxiliary equipment. Accuracy of the model 1300 is within ±5 percent of full scale and rated battery life is in excess of 100 hr.

CIRCLE 306 ON READER SERVICE CARD



Power Supply
short-circuit proof

MID-EASTERN ELECTRONICS, INC., 32 Commerce St., Springfield, N. J. Model ME 36-5M power supply has no external circuit breaker handle and no fuses, yet is virtually short-circuit proof. This is accomplished by means of a fast-acting relay that energizes an internal circuit breaker when the current reaches a preset value, set at the factory at 120 percent of rated current. The supply operates from a source of 95-125 v 60 cycles power regulated to ±0.5 percent. Output voltage is continuously variable over a range of 0 to 36 v d-c with regulation of either 0.1 or 0.01 percent and vernier control at all settings.

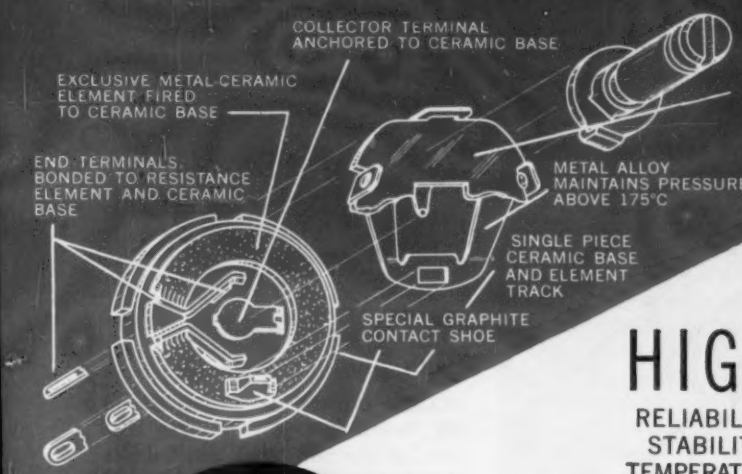
CIRCLE 307 ON READER SERVICE CARD

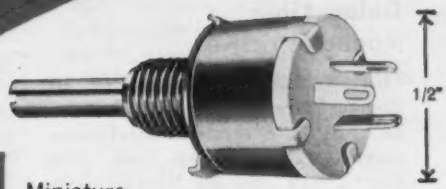
Digital Multimeter
d-c, a-c, ohms

FRANKLIN ELECTRONICS INC., Bridgeport, Pa. Model 500 digital voltmeter has a-c and d-c ranges covering 0.000 to 1,200 v. Ohms range covers from 1 ohm to 1 megohm. Absolute accuracy is 0.1 percent for d-c, 0.5 percent for a-c, and 0.2 percent for ohms. Features include automatic polarity indication, provisions for direct printer operation, and an effectively in-

STABILITY & HEAT BARRIER BROKEN

with Metal-Ceramic Variable Resistor


COLLECTOR TERMINAL ANCHORED TO CERAMIC BASE
EXCLUSIVE METAL-CERAMIC ELEMENT FIRED TO CERAMIC BASE
SILICONE FIBER GLASS ROTOR
END TERMINALS BONDED TO RESISTANCE ELEMENT AND CERAMIC BASE
METAL ALLOY MAINTAINS PRESSURE ABOVE 175°C
SINGLE PIECE CERAMIC BASE AND ELEMENT TRACK
SPECIAL GRAPHITE CONTACT SHOE



HIGH
RELIABILITY
STABILITY
TEMPERATURE

Miniature
CERATROLS
with new metal-ceramic element

CTS®

CeraTrolS' rugged, hard-surfaced metal-ceramic element, having been fired at temperatures exceeding 600°C, meets temperatures up to 500°C with high safety factors at ratings listed below.

New Series 600 Characteristics:

- Infinite resolution.
- 100 ohms thru 5 meghoms (linear taper) resistance range.
- ½" diameter; interchangeable with Style RV6 MIL-R-94B.
- Power ratings: ¾ watt @ 85°C, ½ watt @ 125°C, zero load @ 175°C.

COMPARATIVE TEST DATA: No carbonaceous variable resistors (either film or molded) can equal Series 600 performance. Ideal for critical applications requiring high stability and reliability. Far exceeds MIL-R-94B.

Tests	MIL-R-94B (Style RV6, Char. Y) Requirement	Series 600 CTS Maximum	Series 600 CTS Average
Load life 1000 hrs.			
½ watt @ 125°C, 350 V max.	±10% @ 70°C	±7% @ 125°C	±4% @ 125°C
¾ watt @ 85°C			
Thermal Stability (1000 hrs. @ 175°C no load)	No test in MIL-R-94B	±5%	±3%
Temperature Co-eff.* (Room to −63°C; room to +175°C)	No test in MIL-R-94B		
25K and over		±250 PPM/°C	±150 PPM/°C
under 25K		±500 PPM/°C	±300 PPM/°C
Moisture Resistance	± 6% avg. ±10% max.	± 2% avg. ± 4% max.	±1.3%
Low Temp. Storage	±2%	±1%	±.5%
Low Temp. Operation	±3%	±2%	±1%
Thermal Cycling	±6%	±3%	±2%
Voltage Co-efficient	No test in MIL-R-94B	±.01%/volt	±.005%/volt
Rotational Life	±10% (after 25,000 cycles)	±10%	±7.5%
Acceleration	±3%	±2%	±1%
High Freq. Vibration	±2%	±2%	±1%
Shock	±2%	±2%	±1%

* Lower temperature coefficient can be developed for specific applications.

Note Exceptional Stability. Note extent that MIL-R-94B is exceeded.

Newly developed 500°C Metal-Ceramic Resistance Element is separately available for other applications than variable resistors. Because the element is very stable to 500°C, it is extremely reliable at the elevated temperatures currently demanded and anticipated in military requirements. Ceramic bases can be made in a wide variety of shapes and sizes; the metal resistance film can be made to cover an entire surface or an accurately defined pattern. Consult CTS engineers on your requirements.

Complete Series 600 CeraTrolS electrical and mechanical specs and dimensional drawings will be sent upon request.

CTS manufactures a complete line of composition and wirewound variable resistors for military, industrial and commercial applications. CTS specialists are willing to help solve your variable resistor problems. Contact your nearest CTS office today.

Founded CTS 1896

Factories in Elkhart & Berne, Indiana, South Pasadena, California, Asheville, No. Carolina and Streetsville, Ontario. Sales Offices and Representatives conveniently located throughout the world.

CHICAGO TELEPHONE SUPPLY
Corporation
ELKHART • INDIANA

BURTON BROWNE ADVERTISING

finite input resistance on d-c ranges other than the 1,200 v.

CIRCLE 308 ON READER SERVICE CARD

Delay Lines
magnetostrictive

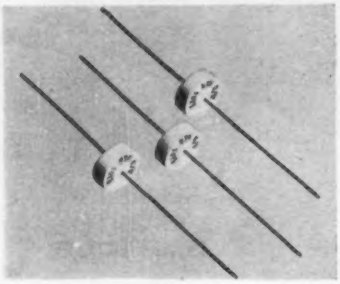
CONTROL ELECTRONICS CO., INC., 10 Stepar Place, Huntington Station, L. I., N. Y. A series of solid state magnetostrictive delay lines with short delays available from 5 to 200 μsec easily withstands vibration to 500 cps at 15 g's and shock to 50 g's. They operate from −55 C to +100 C with a coefficient of less than 20 ppm/deg C. Range of input-output impedances is from 5 to 200 ohms with carrier or pulse frequencies of up to 1 mc. Insertion loss is 54 db. Taps can be supplied and spaced as close as 3 μsec with or without an adjustment feature.

CIRCLE 309 ON READER SERVICE CARD

Compounds
intermetallic

OHIO SEMICONDUCTORS, INC., 1035 W. Third Ave., Columbus 8, Ohio, is now producing commercially a wide range of intermetallic semiconductor compounds for thermoelectric, infrared and electronic applications.

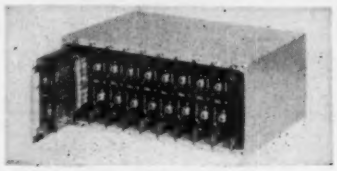
CIRCLE 310 ON READER SERVICE CARD



Silicon Rectifier
five models

AUDIO DEVICES INC., 620 E. Dyer Road, Santa Ana, Calif. The E-5, a wafer-shaped 5/8 in. by 7/16 in. diameter electrically insulated silicon rectifier, is available from stock with solder or plug-in connectors. Five models, rated at 100 piv, 200 piv, 300 piv 400 piv and 500 piv each handle 750 ma with resistive load or 500 ma with capacitive load.

CIRCLE 311 ON READER SERVICE CARD



Signal Conditioner
with plug-in cards

KAUKE AND CO., INC., 1632 Euclid St., Santa Monica, Calif. The NE-10 signal conditioning and balance panel system features an etched circuit plug-in for each transducer panel. In addition to plug-ins for strain gage type transducers, units can be supplied for signal conditioning other types of transducer outputs including thermocouples, potentiometers, etc., for entry into

SHAPED

Transidyne®

TRADE MARK

TRANSISTORIZED
POWER CONVERTERS
AND INVERTERS

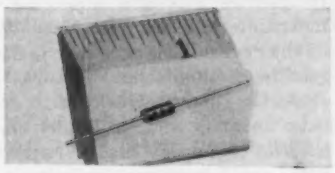
When you need something special in the way of small, extremely efficient (and possibly peculiarly-shaped) power supplies, Spectrol is your source.

Spectrol's Transidyne units offer more options, more exclusive features. Spectrol engineers will design to your specs, including size and shape. You can get these rugged converters or inverters with multiple outputs, high power ouputs, including sine wave *...and up to 4 watts/cu. in. output!*

You will find Spectrol uniquely qualified to meet your special needs for power sources. Transidyne units reflect the same know-how which has made Spectrol the leading supplier of precision potentiometers and mechanisms.

either oscillograph or tape recording systems. Each module container is 3⅞ in. high by 6 in. deep by 8 in. wide overall, and contains provisions for 10 channels.

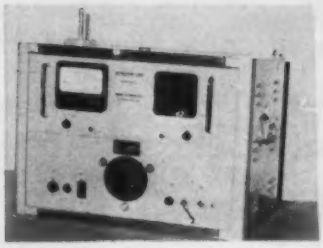
CIRCLE 312 ON READER SERVICE CARD



Precision Resistors wire wound

KAY RESISTOR CORP., 321 W. Redondo Beach Blvd., Gardena, Calif., announces a line of precision wire wound resistors with new high temperature ratings. Smallest in the line, series 20, measures only 0.1 in. diameter by 0.250 in. long, with values from 10 ohms to 150 K ohms. They are especially suited for transistorized circuits. Entire line is rated up to 125 C full load. They are designed to exceed MIL-R-93C Proposed.

CIRCLE 313 ON READER SERVICE CARD



Corona Test Set portable unit

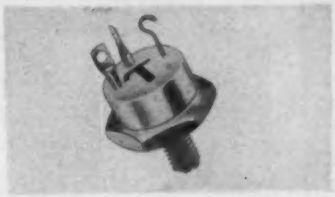
PESCHEL ELECTRONICS, INC., Towners, Patterson, N. Y. Model CT10-0.2 corona test set features a small, portable, self-contained, inexpensive unit for truly nondestructive evaluation of insulation quality. The high-sensitivity corona detection conforms to MIL, ASTM, IPCEA standards. Other features include improved straight line scope presentation, 3 scale kilovoltmeter at output terminals for accurate voltage indication, 3 position scope sensitivity switch, continuously adjustable output voltage 0 to 10 kv rms at 0.25 kva, and zero start on Powerstat output control.

CIRCLE 314 ON READER SERVICE CARD

Tape Winder with 12-in. reel

WESTERN APPARATUS CO., 2001 Greenleaf St., Evanston, Ill. Model TW-5D tape winder is equipped with a stand for sitting on any flat surface of proper dimensions. It has a 12 in. reel and can wind over 2,000 ft of fully perforated tape or over 1,300 ft of chadless tape. Tightness of the wound tape is adjustable. Unit is 16¾ in. high, 12½ in. wide, 6 in. deep.

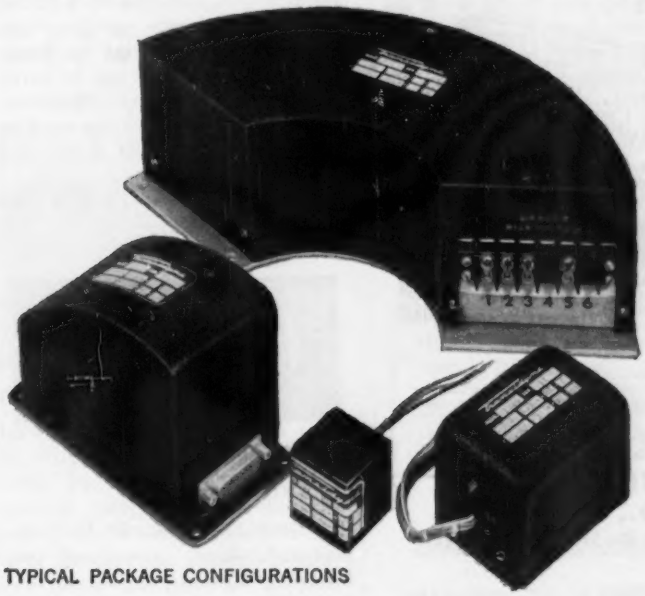
CIRCLE 315 ON READER SERVICE CARD



Silicon Transistor stud-mounted

TRANSITRON ELECTRONIC CORP., 168 Albion St., Wakefield, Mass., announces a new package development in its high power silicon transistor

TO YOUR SPECS!



TYPICAL PACKAGE CONFIGURATIONS

WHAT IS *Transidyne*®?

Transidyne units are solid state devices which convert ac or dc input voltages to ac and/or dc outputs of different voltage levels or frequencies. Typically, a dc input voltage can be converted to ac sine wave output voltage having a frequency of 2,000 cps.

Small and lightweight, Transidyne equipment completely replaces motor-generator and vibrator type devices... having greater efficiency. They are used in all types of military and commercial electronic and electrical devices requiring rugged, reliable power supplies.

Let us quote on your special power source requirements. Call your nearest Spectrol representative, or write us direct. Please address Dept 1811 .

SPECTROL

ELECTRONICS CORPORATION
1704 SOUTH DEL MAR AVENUE
SAN GABRIEL, CALIFORNIA

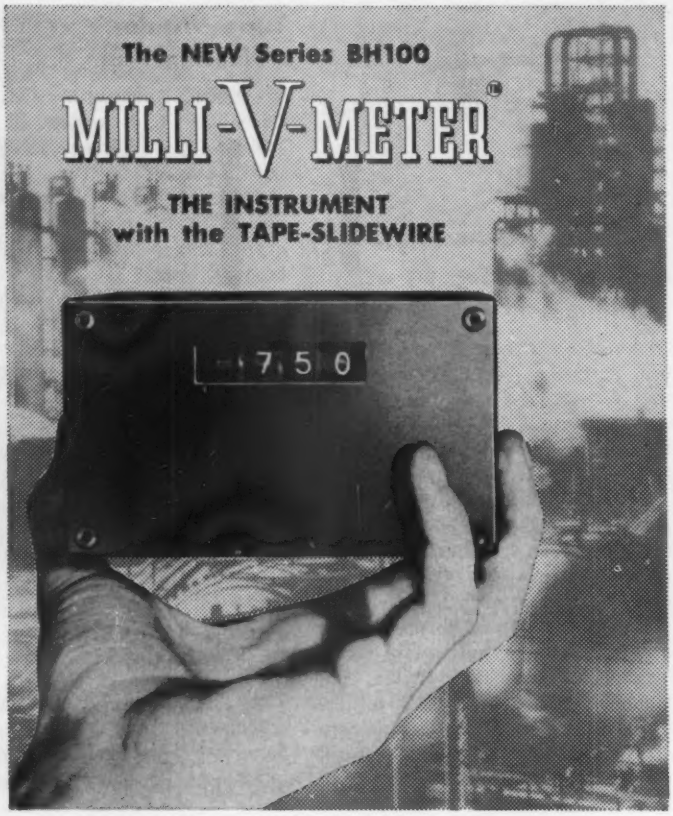
19

CIRCLE 109 ON READER SERVICE CARD

The NEW Series BH100

MILLI-V-METER®

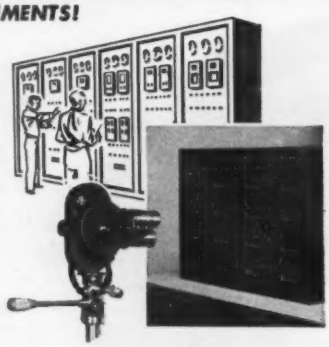
THE INSTRUMENT with the TAPE-SLIDEWIRE



1/10 THE SIZE... 10 TIMES THE ACCURACY

OF STANDARD INSTRUMENTS!

- Resolution: 1 part in 10,000
- LABORATORY PRECISION for the operating plant.
- COMPATIBLE with any transducer —AC or DC.
- For strain gage, thermocouple, linear differential transformer, thermistor, resistance thermometer, pulse or variable frequency circuits or systems.
- Parabolic or logarithmic functions are linearized for direct digital reading.
- Every scale unit is a calibrated value.



Produced by the makers of the JETCAL® jet engine Analyzer... in worldwide military and airline use!

Full information is available for the asking!

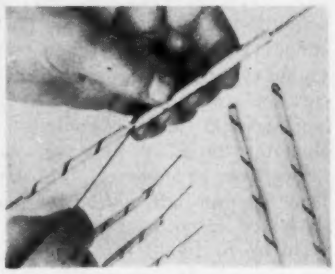
B & H INSTRUMENT CO., INC.

3479 West Vickery Blvd., Fort Worth 7, Texas

Sales-Engineering Offices:
ATLANTA, GA., COMPTON, CAL., DAYTON, OHIO, VALLEY STREAM, L.I., N.Y., WICHITA, KAN.
TORONTO, ONT. (George Kelk Ltd.) MITCHAM, SURREY, ENGLAND (Bryans Aeroquipment Ltd.)

line—the 2N1208, 2N1209, and 2N1212. The rugged stud-mounted package combines durability with performance. The ¼ in. hex-nut single stud construction contributes to greater strength and ease of mounting, and electrical insulation of the device from heat sink is more readily accomplished. Features include low thermal resistance, good beta linearity and switching characteristics, good high frequency beta, and low saturation voltage.

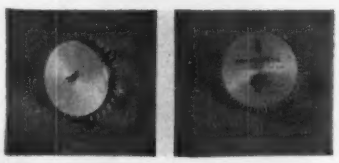
CIRCLE 316 ON READER SERVICE CARD



Insulating Beads peelable sleeve

SAXONBURG CERAMICS, INC., Saxonburg, Pa. Articulated ceramic insulating beads in patented paper tubes that peel away after stringing allow 6 or 12 in. of wire to be bead insulated in 1 sec. This is accomplished by stringing the full tube length of beads on wire with one insertion then pulling a string that splits and removes the paper tube. Users claim as high as 75 percent assembling time can be saved by using this method. "Beads-in-sleeves" are available from stock in sizes 0.110 in. to 0.400 in. o-d and 0.056 in. to 0.156 in. i-d.

CIRCLE 317 ON READER SERVICE CARD

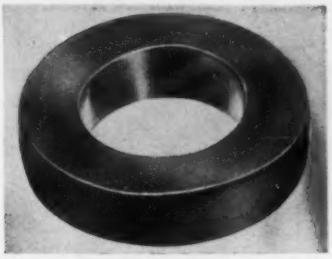


Precision Pot multitapped

PRECISION LINE INC., 63 Main St., Maynard, Mass., announces pots featuring taps set precisely to ±0.1 deg as close as every 5 deg over a

360 deg winding. Units with multi-taps can be supplied in various diameters down to and including 1 in. with resistance values up to 50 K ohms depending on the case diameter. Ambient temperature of the units is −50 C to +100 C or higher. They are designed to meet salt spray, humidity, vibration and shock requirements of MIL specs and NAS-710.

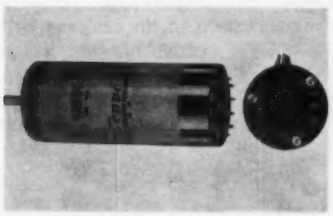
CIRCLE 318 ON READER SERVICE CARD



Tape Wound Cores
nickel-iron

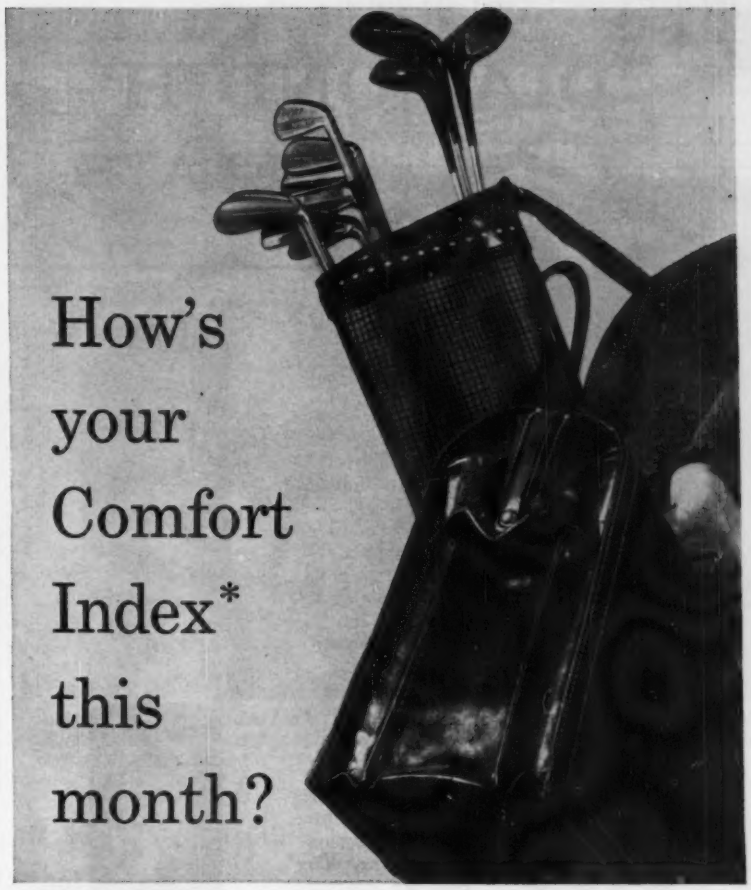
G-L ELECTRONICS, INC., 2921 Admiral Wilson Blvd., Camden 5, N. J. Highly refined, vacuum melted, nickel-iron tape wound cores are designed for use in low level input magnetic amplifiers, wide band toroidal transformers and radar pulse transformers. Super Hymu "80" cores are guaranteed to have an initial permeability greater than 55,000 tested at 20 gauss, 100 cps. Units are oil damped and sealed in an aluminum case.

CIRCLE 319 ON READER SERVICE CARD



Resolvers
amplifierless

CLIFTON PRECISION PRODUCTS CO., INC., 9014 West Chester Pike, Upper Darby, Pa. Size 11 amplifierless resolvers incorporate an integral transformer which simulates a resolver function at maximum coupling. They are used in a chain application for angular data trans-



Jack Lightfoot, LOCKHEED staff engineer working on the Polaris Missile for the Navy, explains why the COMFORT INDEX in Santa Clara County means better living to him. "It doesn't matter whether it's January or July around here – I can take off for the golf course any week end. And, frankly, I feel that I accomplish more on the job in this all-year mild climate."

Both management and employees have a lot to gain from the mild Santa Clara County climate. Productivity goes up as your COMFORT INDEX approaches the ideal level. But you get *more* than exceptional livability. This unique location at the Southern tip of San Francisco Bay places Santa Clara County right in the *market and transportation center* of the West.

First, compare the COMFORT INDEX of each potential industrial site. When you add the other advantages, every fact points to SANTA CLARA COUNTY – for maximum *livability* and *productivity*.

*COMFORT INDEX—One of many terms used to describe the exact point at which the climate of a particular area approaches an ideal combination of moderate temperature, low humidity.

SEND TODAY for these two booklets and bring your plant site research file up to date: **"What Do You Mean – COMFORT INDEX?"** and **"NEW INDUSTRY SPEAKS".**

GREATER SAN JOSE CHAMBER OF COMMERCE
Dept. 13, San Jose 13, California

SANTA CLARA COUNTY • California

'DIAMOND H' RELAYS

NEW . . . High Speed Polarized Relays

Fast action with freedom from bounce, plus high sensitivity and consistent operation with low distortion, are provided by small, rugged Series P Polarized Relays. SPDT, with two independent coils, they will handle over 1,000 pulses per second. Various coil resistances up to 5,000 ohms each coil. Contact ratings vary with switching speed but range from 60 MA to 2A with voltages to 120 AC or DC, dependent upon amperages employed.

Aircraft-Missile Series R & S Relays

Miniature, hermetically sealed 4PDT, Series R & S relays provide excellent reliability over their long service life. Electrically and physically interchangeable, the two series differ only in that Series S coils are separately sealed within the sealed cases, with organic matter eliminated from the switch mechanism for greatest reliability in dry circuits. Contacts MA to 10 A.

General Purpose AC, DC Relays

Series W Power Relays are DPDT, double break-double make; measure only 1½" x 1½" x 1⅞", but are rated to 25 A, resistive, at 112-230 V, AC, 1 HP 115 V, AC, 2 HP, 230 V, AC. Socket, panel and sidewall mountings are standard; others available to meet special needs. 12 possible contact arrangements, including sequencing.

"Diamond H" engineers are prepared to work with you to develop variations on these relays to meet your specific requirements. Tell us your needs . . . by phone or letter.

THE HART MANUFACTURING COMPANY

202 Bartholomew Ave., Hartford 1, Conn.

Phone JAckson 5-3491

CIRCLE 112 ON READER SERVICE CARD

mission. Accuracy is ± 5 minutes of arc or less; winding perpendicularity, ± 5 minutes. Electrical characteristics include: Input to either rotor or stator. Input voltage 115 v 1600 cycles; output voltage, 110 v both stator and rotor as primary; phase shift (stator primary), 1.1 deg; phase shift (rotor primary), 1.9 deg.

CIRCLE 320 ON READER SERVICE CARD

Proportional Oven transistorized

BLILEY ELECTRIC CO., Union Station Building, Erie, Pa. Type BPCO-1 proportional control oven for crystals and components features temperature stability of ±0.02 C held over an ambient range of +10 C to +50 C. Heat chamber is 1¼ in. diameter by 2 in. long. It will accept series BG6 and BG7 glass crystal units. Oven operates on a 26 v supply and can be furnished with operating temperatures, as specified, in range +70 C to +85 C. Seated height: 4⅞ in. (above octal base). Cross section: 2¼ by 2¼ in.

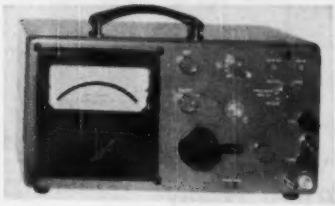
CIRCLE 321 ON READER SERVICE CARD

Linear Motion Pot high temperature

BOURNS INC., P.O. Box 2112, Riverside, Calif. Model 113 linear motion pot is designed to operate at

temperatures from −65 F to +500 F. It will give precisoin electrical indication of mechanical position when used with hydraulic actuators, pneumatic valves and linkage components. The instrument operates with a high level a-c or d-c signal, requiring no amplification for use in recording, control and telemetering circuits. Size is ½ in. by ⅝ in. by 2½ in.; travel range, 0-1.31 in.; power rating, 4.0 w at 40 C.

CIRCLE 322 ON READER SERVICE CARD

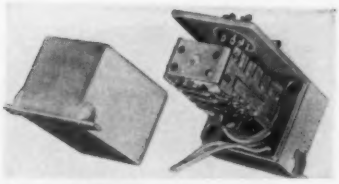


Electronic Ammeter

battery powered

BELLEVILLE-HEXEM CORP., 638 University Ave., Los Gatos, Calif. Featuring transistorized circuitry, model 120 measures current from 1 $\mu\mu$a through 300 ma full scale in 24 ranges. Accuracy of indication is ±1.0 percent from 1 millimicroampere through 300 ma and ±2 percent from 1 $\mu\mu$a through 300 $\mu\mu$a. Design features include low-drift electrometer tube input, feedback with high loop gain for circuit stability, high overload capability, 1,500 hr battery life, and use of p-c techniques. Price is $745.

CIRCLE 323 ON READER SERVICE CARD

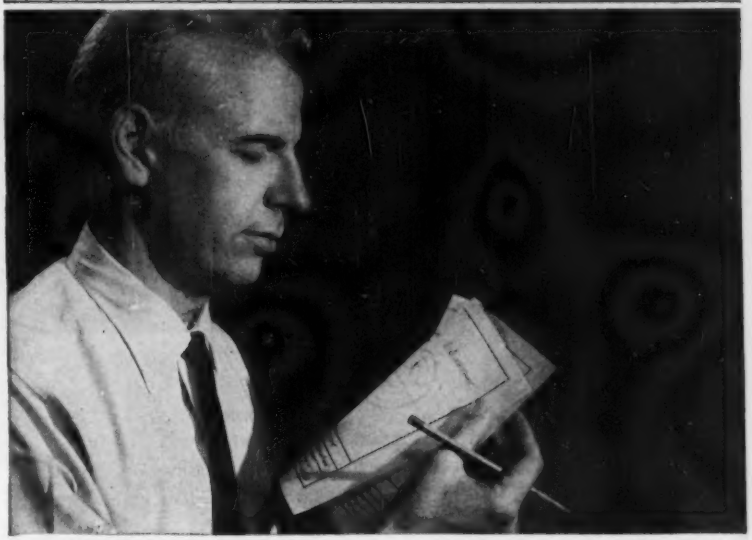


Cam Switch

solenoid-operated

TECH LABORATORIES, INC., Edsall Blvd., Palisades Park, N. J. The C-3837 is a hermetically sealed, miniaturized, solenoid-operated cam switch guaranteed for at least 100,000 cycles of operation and 800,000 contact breaks. It has been

DRAFTING TRENDS



Compare the true vellum feel! This new sepia feels and handles like the best vellums. You can make this comparison test yourself—write for the Vapo-Vel Portfolio offered below.

A sepia intermediate that handles like the best vellum

Intermediates have been used for years to speed drafting and alter original drawings. But up to now most have had drawbacks such as . . . cost, premature spoilage, inconsistency in print image and variable drafting qualities.

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New standard for intermediates

New POST Vapo-Vel 209 combines every important feature you've been looking for in a transparentized paper base print—top drafting qualities, superior shelf-life and filing characteristics, and outstanding printback speed. It is produced under POST "Control Coated" conditions to assure consistently uniform prints.

To the man on the board, this newly improved Vapo-Vel is a real find. It has all the drawing and transparency features of a top-notch vellum, even that crisp vellum "feel." Vapo-Vel's easy-to-read dark brown image and outstanding transparency eliminates eyestrain in modification work on the back of reverse-reading prints. The surface takes pencil well, and inks without feathering. Pencil erasing characteristics of this strong 100% rag premium paper are truly outstanding, while eradication of print images is easily accomplished.

New test kit available

Write today for the POST Vapo-Vel Portfolio. It contains sample prints to examine and test, a Print Characteristics Checklist, a Data Sheet and a copy of POST's popular booklet "11 Ways to Save Drafting Time." To keep up-to-date with the latest, just write Frederick Post Company, North Avondale Avenue, Chicago 18, Illinois.

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shock and vibration tested in accordance with MIL-E-5272A. Operation is from 24 to 30 v d-c at 125 C ambient temperature. Current rating is 1 ampere. Unit is designed for 7 pole, 18 position shorting with interrupter and homing features.

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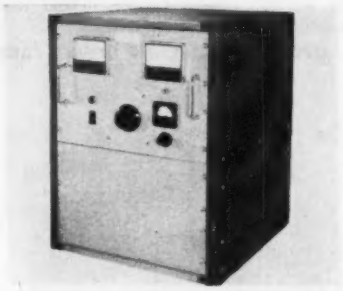


Power Supply solid state

AEROLAB DEVELOPMENT CO., 330 W. Holly St., Pasadena, Calif. Transistorized 1,000 w solid state power supply is continuously variable over complete range of 0 to 600 v d-c. It is available in standard rack/console type construction. Input is 115 v, 60 cycle a-c. For load variations from zero to full load and input line variations of ±10 percent, the output regulation is within 0.01 percent. Ripple is less than 3 mv rms; stability 0.1 v drift maximum over an 8 hr operating period. Applications are in ground support and checkout equipment; laboratory high power requirements.

CIRCLE 325 ON READER SERVICE CARD

Spectrum Analyzer wave and noise

QUAN-TECH LABORATORIES, 236 Mt. Kemble Ave., Morristown, N. J. Model 303 wave and noise spectrum analyzer is an all-transistorized unit. It will measure the harmonics of the majority of ultrasonic transducers. A switch selects any of

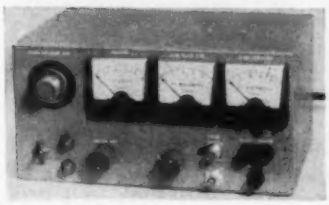
four constant bandwidths. The two broadest positions are flat topped, greatly increasing the simplicity and accuracy of noise measurements, and facilitating tuning at high frequencies. The sharpness of the narrow band positions is adequate for practically all applications. Frequency range is 30 cps to 100 kc; dial calibrations, approximately exponential (accuracy ±5 percent or 10 cps); vernier frequency dial, ±300 cps.

CIRCLE 326 ON READER SERVICE CARD

Block Reader for punched tape

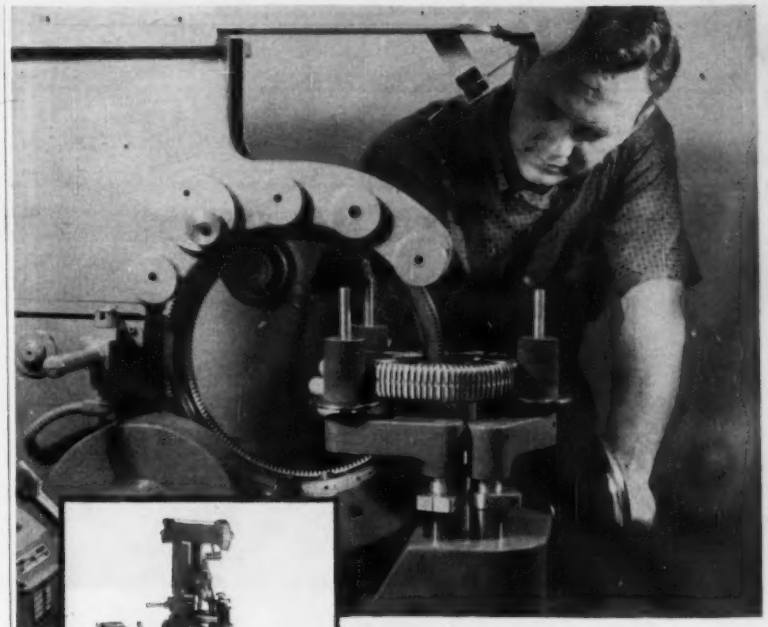
WANG LABORATORIES, INC., 12 Huron Drive, Natick, Mass., has a new series of block readers for standard 1-in., 5 to 8-hole paper, or Mylar tapes. It is designed to read a fixed block of information in any number up to 48 lines (up to 384 bits) on the tape all at once. Output terminals are available conveniently for all bits through special alloy triple-wire brush contacts. Unit has been tested to run for millions of readings without error. It is especially useful for numerically controlled systems, automatic programming and automatic testing.

CIRCLE 327 ON READER SERVICE CARD



Pulse Modulator compact, light

BOMAC LABORATORIES, INC., 1 Salem Road, Beverly, Mass. The BL-P-030 pulse modulator is capable of powering small magnetrons requiring inputs of up to 10 kw peak at



NEW BOESCH MAXITOR

winds toroids from #40 to #7 wire . . . using 3 interchangeable heads

Boesch's new MAXITOR Toroidal Coil Winding Machine covers a wide range of applications, including exceptionally large diameter, heavy wire gauge winding jobs. The coil shown above is typical. It is being wound with #10 wire on a MAXITOR machine using Boesch's HW-200 winding head and continuous-winding core holder. Segmental-winding holder is also available.

Two other interchangeable heads are available which make MAXITOR a really versatile machine. The HW-300 head winds wire gauges as large as #7 to finished O.D. as much as 14". HW-100 handles gauges from #40 to #22 to maximum O.D.'s of 10".

And MAXITOR is packed with "dream" features. Pushbutton drive ring and magazine positioning saves set up time. A dial control on the operator's panel provides micrometer brake settings for easiest variable speed tension control. Turn spacing is infinitely variable at the turn of a knob. And the range of winding applications for MAXITOR is apparent in the table below.

Head Type	Min. Final I.D.	Max. Final O.D.	Max. Final Height	Wire Range AWG #
HW-100	½"	10"	6"	40 to 22
HW-200	1"	10"	6"	24 to 10
HW-300	2"	14"	10"	20 to 7

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a duty cycle of up to 0.002. Pulse widths from 0.1 to 2 μsec can be supplied. Meters are provided for pulse voltage, average magnetron current, and magnetron filament current. Jacks are also provided for monitoring peak pulse current, pulse voltage and the trigger repetition rate.

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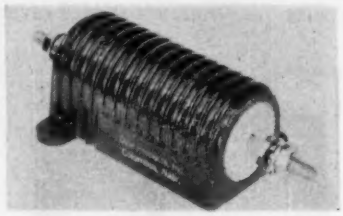

Power Resistor rated at 100 w

DALE PRODUCTS, INC., Columbus, Neb. The RH-100 wire-wound precision power resistor is sealed in an aluminum radiator finned housing for mounting on chassis to provide maximum heat dissipation. It is available in 0.05, 0.1, 0.25, 0.5, 1 and 3 percent tolerance with resistances ranging from 0.25 ohm to 40 K. Housing size is 3½ by 2⅛ by 1⅞ in. Terminals are plated ¼-20 studs.

CIRCLE 329 ON READER SERVICE CARD

Magnetic Triggers full-wave

AVION DIVISION, ACF Industries, Inc., 11 Park Place, Paramus, N. J. Model 410 series of full-wave magnetic triggers are compact, packaged components designed for use with C35 or equivalent series of silicon controlled rectifiers. Transfer characteristic is largely independent of voltage and frequency

of the primary power supply. Operating range is from 50 through 400 cps. Output presents a steep wavefront to the gate circuit of the scr, allowing precise determination of firing angle. The unit is insensitive to line transient such as switching surges, commutator noise, and capacitance to ground.

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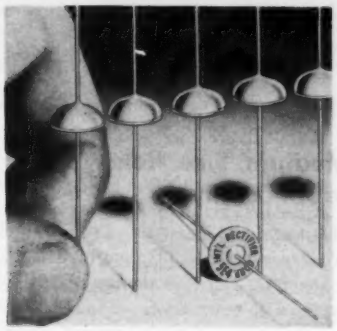


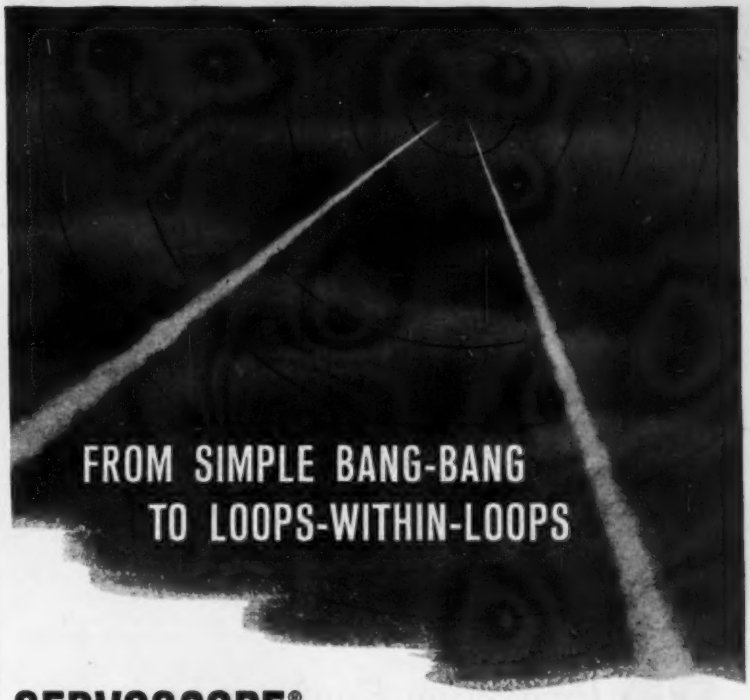
Silicon Diodes
commercial type

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., has available low cost, high temperature, 400 piv-rated silicon diodes. Specifically designed for tv, radio and commercial equipment applications, the units are operable to 70 C ambient temperature (100 C case temperature). The 2E4 diode is rated at 200 ma at 400 piv, and the 5E4 is rated at 350 ma at 400 piv. All units are multi-sealed with successive layers of humidity-resistant, insulating resins and sealants.

CIRCLE 331 ON READER SERVICE CARD

Toggle Switches
subminiature

HAYDON SWITCH, INC., Waterbury 20, Conn. The 5300 series toggle switch assemblies are available with from 1 to 8 pdt contact arrangements. Toggle actuation can be either 2 or 3 position, and furnished in various combinations of



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Removes the Doubt All the Way

with complete 5-minute analyses!

Whether a servo system must operate dependably for expediting change of course to avoid mid-air collision, or lock-on to impact...

Whether a servo system is a sophisticated inertial guidance system with multiple feed-back loops, or a simple "bang-bang" on-off set-up...whether it leads to a launch, a scramble, or a takeoff...there can be no room for doubt!

SERVOSCOPE servo system analyzers remove all doubt. The full line of five models provides these essential features:

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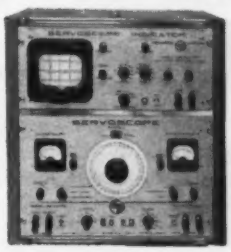

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momentary and maintained positions. Switches are rated at 5 amperes resistive, 3 amperes inductive, at 30 v d-c and 115 v a-c, and are available in three terminal designs —solder hole type, turret type, or double turret type.

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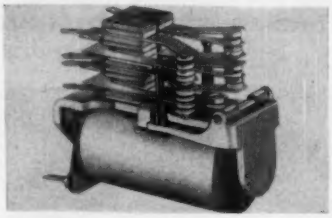
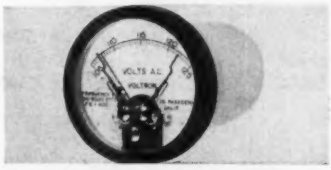


Medium Size Relay telephone type

MAGNECRAFT ELECTRIC CO., 3350 B W. Grand Ave., Chicago 51, Ill. Class 66A relay is designed for 60 cycle a-c operation. Shaded pole construction, with excellent magnetic materials in the iron circuit and short operating arm to armature ratio, assures maximum contact pressures. Available with contact combinations up to 4pdt with a wide selection of contacts for all kinds of applications ranging from bifurcated twin gold alloy contacts for low level switching to heavy duty power contacts for switching up to 15 amperes at 115 v a-c non-inductive load.

CIRCLE 333 ON READER SERVICE CARD

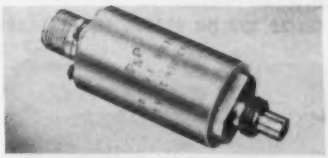


Meter-Relay expanded scale

VOLTRON PRODUCTS, 1010 Mission St., South Pasadena, Calif., and Assembly Products, Inc., Chesterland, Ohio, have jointly produced an expanded scale meter-relay with four to ten times greater accuracy and reliability. It provides 10,000,000 make-break cycles with 100 percent perfect contact; requires low current and voltage inputs; eliminates problem of load isolation in measuring circuits; offers a number of

new features that can monitor and control any variable that is measured electrically. It is available in 2½, 3½ and 4½ in. models.

CIRCLE 334 ON READER SERVICE CARD



A-C Solenoid
400 cycle

PSP ENGINEERING CO., 6058 Walker Ave., Maywood, Calif. Solenoids using internal rectifiers gain the efficiency of an a-c transmission system, yet retain the magnetic efficiency of a d-c solenoid. The 400 cycle solenoids are used principally in airborne systems, but are also well suited for aircraft electronics, computers, instruments, valves and ground support equipment. They are manufactured in general accordance with MIL-S-4040C and meet environmental requirements of MIL-E-5272B and MIL-E-5400. They operate efficiently from −65 F to +250 F.

CIRCLE 335 ON READER SERVICE CARD

Rotator/Indicator
heavy duty

TELREX LABORATORIES, Asbury Park, N. J. Model 500 RIS rotator/indicator system rotates and holds large arrays in winds up to 120 mph. It is lifetime lubricated and protected from −55 to +400 F. Rotating power is 5,000 in./lb; braking power 12,000 in./lb. Other features: limit of rotation and selsyn indication built-in; special motor and circuitry requiring only 8 conductor cable; azimuth indication by selsyns. Price is $435.

CIRCLE 336 ON READER SERVICE CARD

Tantalum Capacitor
solid electrolyte

P. R. MALLORY & CO., INC., 3029 E. Washington St., Indianapolis 6, Ind. The resin-encapsulated type TAM is the latest solid electrolyte

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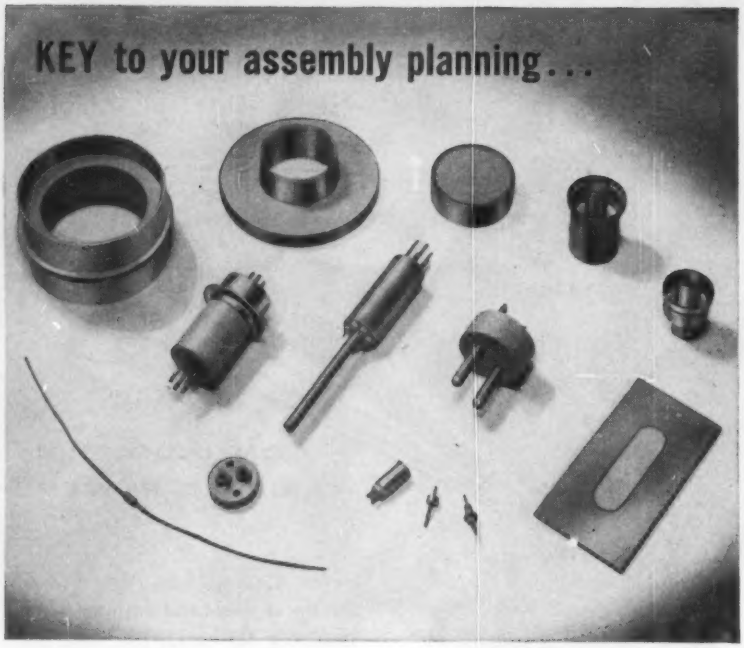

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Frenchtown Engineering Bulletin 1155 contains complete details and data on MOLCOTE Metallized Coating for Ceramics. We'd be pleased to send you a copy for use in your assembly planning. A good time to write for it is *NOW*.

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FRENCHTOWN, NEW JERSEY

tantalum capacitor in the company's line. It is especially suited for printed circuits; its small size and easy-mounting leads are a big advantage. It is fully insulated for compact mounting and has grid-type leads which permit mounting above the chassis.

CIRCLE 337 ON READER SERVICE CARD

Subminiature Pot leadscrew actuated

BOURNS, INC., P. O. Box 2112, Riverside, Calif. Model 220 Trimpot has a power rating of 1.0 w, a maximum operating temperature of 175 C, and is available in resistances from 100 to 20 K ohms. Measuring $\frac{3}{16}$ by $\frac{3}{16}$ by 1 in., the units are designed for use with p-c boards and modular type assemblies. They meet or exceed government specifications for humidity, shock, vibration and acceleration.

CIRCLE 338 ON READER SERVICE CARD

Converters a-c to d-c

NON-LINEAR SYSTEMS, INC., Del Mar, Calif. Series 125 a-c to d-c converters have a frequency range of 30 cps to 10 kc; voltage range, 0.001 to 999.9 v in steps of 9.999/99.99/999.9 v; scale multiplier, voltage and frequency linearity, all accurate to ± 0.1 percent. With 10 megohm input impedance and 20 $\mu\mu$f shunt capacitance, the converters draw a negligible amount of current from circuits under test.

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Gear Motor high torque

NEW ENGLAND GEAR WORKS, 557 South End Road, Southington, Conn., announces a small, powerful gear motor. Smooth and quiet, it can be had at any single speed from $\frac{1}{2}$ rpm to 1,000 rpm with torques up to 1/20 hp and 175 in. lb at 10 rpm. Built for long life and hard usage with ball bearing

motor, generated gears and pinions of hardened steel and with large felt oil reservoir touching every journal. The 2 pole, shaded pole motor is free from radio and tv interference.

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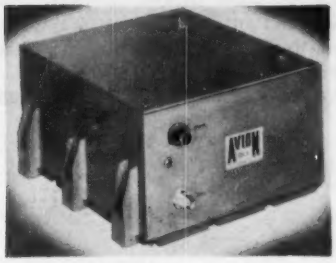

Radar Beacon long-range

AVION DIVISION, ACF Industries, Inc., 11 Park Place, Paramus, N. J. Type 149 is a radar beacon designed as an airborne, pulse-type tracking aid for long-range missile or space application. Completely transistorized except for the local oscillator and the transmitter, it features high reliability and long life, and combines sturdy construction with small size, light weight and low power consumption. The beacon operates in the C-band or S-band and responds to coded or uncoded pulse interrogations from radars, such as those used in a radar-guided missile instrumentation system.

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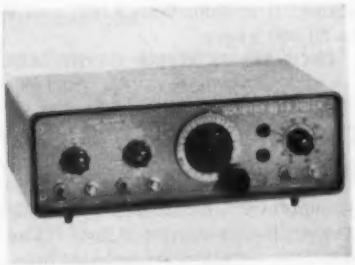

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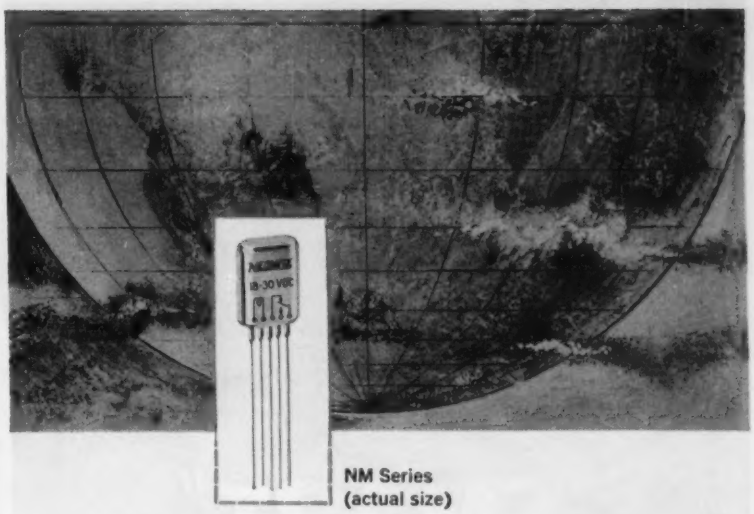

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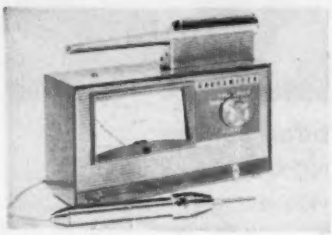

Gaussmeter direct-reading

F. W. BELL, INC., 1356 Norton Ave., Columbus 8, Ohio, has developed a direct-reading gaussmeter designed to measure direction and magnitude of flux density. Operating on the Hall Effect, model 100 gaussmeter uses as its sensing element a thin wafer of high-purity indium arsenide with a temperature coefficient of 0.1 percent. The active area of the sensing element is equal to a circle of 0.0625 in. diameter. A convenient scale selector on the front panel gives gauss readings in three scales: 0 to 300, 0 to 3,000 and 0 to 30,000 gauss.

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Computer Diode silicon junction

MICROWAVE ASSOCIATES, South Ave., Burlington, Mass. The MA-4223 miniature, silicon junction computer diode is designed for use in computer circuits which require low capacity and very fast recovery time components. When switched from the forward bias with 10 ma current flowing to reverse bias of −5 v, the complete recovery time is 4 milliμsec maximum. Operating temperature of the

glass packaged diodes is from −65 to +100 C. They have axial wire leads which are readily soldered into computer circuits for reliable performance.

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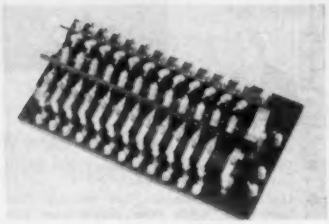

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AUTOMATIC SWITCH CO., Florham Park, N. J. Mechanically held 25-ampere a-c relays are now available up to 24 poles. Increased number of poles permits wider utilization of these relays as primary relay devices controlling contactors, solenoid valves and similar equipment, or as branch circuit devices directly controlling electric ovens and furnaces, lights and other loads within their capacity.

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Radiator Tube Clamp
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TROUGHT ASSOCIATES INC., 116 Greylock Ave., Belleville, N. J. Weighing only 1 oz and occupying a cube of just 1¼ in. this new heat dissipating anode connector has been developed for use with type 545, 554, 589 and 6339 external anode high vacuum miniaturized power diodes in either air-cooled or oil-cooled applications. It maintains uniform anode contact over a wide temperature range up to 300 C. Significant extension of the tube life and increased ratings are obtained as a result of improved heat dissipation provided by the finned radiator.

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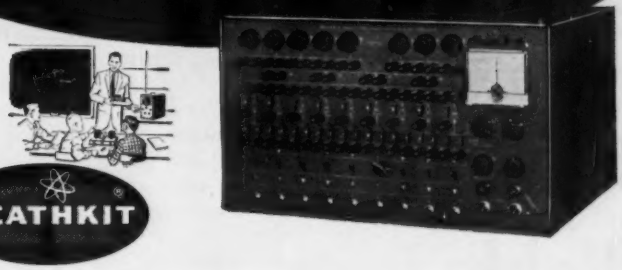

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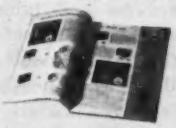

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NEW BOOKS

Radio Engineering Handbook

Edited by KEITH HENNEY.
McGraw-Hill Book Co., New York, 1959, 1,800 *p*, $25.00.

THIS is the fifth edition of what has become a standard work. All chapters have been brought up to date, seven completely rewritten and seven new chapters added. Among the latter are chapters on wire telegraphy and telephony, so that, as the editor says, this edition "becomes a 'communications' handbook, and not one concerned solely with space-guided transmission."

And what an imposing array of practical and useful information is contained in this massive volume! An excellent opening survey chapter on radio-communication engineering covers succinctly but effectively such fundamentals as the nature of signals, modulation, the properties of matter, statistical theory, electromagnetic theory, and the physiological aspects of communication engineering. The three following sections deal with basic circuit elements—resistance, inductance and capacitance.

Following these are chapters on wave guides and resonators, electron tubes for low and medium frequencies, microwave tubes, semiconductor diodes, and transistors. The book then moves from components to chapters on circuits such as nonlinear circuits, amplifiers, oscillators and power supplies. The remaining chapters are in general devoted to systems and applications in communications. These include excellent entries on transmitters and receivers, broadcasting, facsimile, avigation and electronics in aviation.

The book is profuse with charts, diagrams, nomograms and tables, most of which are extremely useful. The emphasis throughout appears to be on practical application rather than heavy-handed theory, which is as it should be in a handbook of this type.

One might quarrel with the relative weight assigned to some of the topics. For example, the chapter on transistors contains 44 pages;

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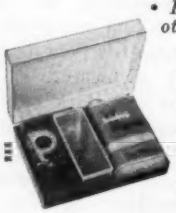

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the section immediately after on loadspeakers and room acoustics is 48 pages. Admittedly, length is not the criterion by which quality is judged, but in this case the balance appears poor.

This is a petty grievance, however, in the overall picture since the book is a reference work which will be of inestimable value to engineers and designers in this field. —S.W.

Wave Propagation and Antennas

By GEORGE B. WELCH.

D. Van Nostrand Pub. Co., Inc., Princeton, N. J., 1958, 257 *p*, $5.75.

THIS book is intended for students on a level equivalent to college sophomores ". . . who are presumed familiar with general physics, trigonometry, and a little analytic geometry" to provide them with ". . . a general background knowledge of electromagnetic propagation . . . and antennas."

The author, Professor of Physics at Northeastern University, undertakes to elucidate principles of traveling and standing waves on transmission lines; refraction, intereference and diffraction; radiation and directivity of antennas, and propagation through hollow waveguides as well as the practical import of these without recourse to additional mathematics. The need for a collateral text of this kind, which could impart perspective to precede more formal theory, has been felt by undergraduate instructors in electromagnetic theory for some time. It should serve the same general purpose for interested individuals not actually attending classes.

The author is generally successful in carrying through the above cited objectives. The physical arguments and analogies by means of which he seeks to circumvent the mathematics are generally plausible and often illuminating. One noteworthy feature of the book is the inclusion of phenomena which have only been appreciated quite recently such as forward scatter and the Hydrogen Line. Perhaps these advantages are attributable to the fact that the author is a physicist,

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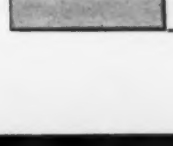

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rather than an electrical engineer; the same could be said of certain omissions. Phasor notation for sinusoidal quantities is not introduced, although it would be very useful. In fact, it is difficult to see how impedance may be interpreted without this concept. Reference is made to knowledge of impedance that the student might have from physics courses, but why not take advantage of the simplification of phasor notation starting from the first chapter?

There are a number of misstatements which should be corrected in a subsequent edition. For example, the important reciprocity theorem is improperly put. Strictly, the statement given reflects only the symmetry of the circuit cited as an illustration, not reciprocity at all. The superposition of a TE_{01} and a TE_{10} mode in rectangular waveguide is said to result in the TE_{11} mode configuration. This contradicts the basic idea of the independence of these modes (mode orthogonality).

Despite the noted shortcoming, the book should prove useful both in and out of the classroom.

WALTER K. KAHN, *Microwave Research Institute, Polytechnic Institute of Brooklyn, N. Y.*

THUMBNAIL REVIEWS

History of Mathematics (two vols). By D. E. Smith, Dover Publications, Inc., New York, 1958, 1,321 p, $5.00 per set or $2.75 per vol. Vol. 1 considers the history of mathematics chronologically arranged by man and country; vol. 2 is arranged by subject and discusses evolution of different divisions of mathematics. Wealth of problems, recreations, constructions, applications explained and illustrated makes this a useful and interesting reference set for electronics engineers.

Medical Electrical Equipment. R. E. Molloy, advisory editor (21 contributors), Philosophical Library, Inc., New York, 1959, 312 p, $15.00. Information on principles, operation, care and routine maintenance of medical electrical apparatus is given. Of particular interest to electronics engineers are discussion of electronic flash tubes for automatic color cameras, x-ray equipment, radiation detectors, diathermy equipment, physiotheropeutic stimulators, ultrasonic therapy devices, electromyographs, electro-

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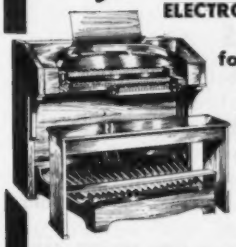

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Logical Design of Electrical Circuits. By R. A. Higonnet and R. A. Grea, McGraw-Hill Book Co., Inc., New York, 1958, 220 p, $10.00. Boolean methods for analyzing relay, diode and vacuum-tube circuits used in design of automation, computer and telephone dialing systems.

Transistors—Theory and Practice. By R. P. Turner, Gernsback Library, Inc., New York, 1958, 160 p, $2.95. This second edition corrects statements regarding transistor limitations acceptable at time of first edition. Also, additions and changes consistent with improvement of art have been made and obsolete material removed.

Analytical Transients. By T. C. G. Wagner, John Wiley & Sons, Inc., New York, 1959, 202 p, $8.75. After a general introduction to methods of network analysis, this text delves into its details. Much of the discussion is devoted to Laplace transformation, which is introduced via Fourier series and integrals.

Vacuum Tube Rectifiers. By A. Schure, John F. Rider Pub., Inc., New York, 1958, 78 p, $1.50. Theory, characteristics and circuitry of rectifiers and filter circuits.

Handbook of Mathematical Tables and Formulas. Compiled by R. S. Burington, Handbook Publishers, Inc., Sandusky, Ohio. Excellent reference in two parts: formulas and theorems from elementary mathematics, and tables.

Cryogenic Engineering. By R. B. Scott, D. Van Nostrand Co., Inc., Princeton, N. J., 1959, 368 p, $5.60. Serves as introduction to cryogenic or low-temperature engineering for engineers unfamiliar with cryogenic techniques, but who must employ them in designs and investigations.

Glass Engineering Handbook. By E. B. Shand, McGraw-Hill Book Co., Inc., New York, 1958, 484 p, $10.00. This second edition contains sections on glass technology, manufacture, applications and fibrous glass. The section on applications includes chapters on electron tubes and electronic circuit components.

Handbook of Practical Electroplating. By T. M. Rodgers, Macmillan Co., New York, N. Y., 333 p, 1959, $8.50. Encyclopedic coverage of actual practices used in plating shops.

Handbook of Electronic Control Circuits

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Literature of

MATERIALS

Coated Fabrics. The Connecticut Hard Rubber Co., 407 East Street, New Haven 9, Conn. A 2-page technical data sheet contains a description and typical properties of stock item silicone rubber coated fabrics.

CIRCLE 385 ON READER SERVICE CARD

COMPONENTS

Precision Pots. Guidance Controls Corp., 110 Duffy Ave., Hicksville, N. Y. A set of six data sheets, one for each model, is available on the company's line of precision pots which incorporate a new and ultra-precise method of mandrel winding.

CIRCLE 386 ON READER SERVICE CARD

Elapsed Time Indicator. Waltham Precision Instrument Co., 221 Crescent St., Waltham 54, Mass. Specifications and performance capabilities of the WT-1 subminiature elapsed time indicator are described in bulletin 5001. Included are dimension drawings and an actual size template for panel layout.

CIRCLE 387 ON READER SERVICE CARD

Waveguide Filters. Waveline Inc., Caldwell, N.J. A 4-page bulletin illustrates and describes a sampling of representative types of waveguide filters designed and manufactured by the company.

CIRCLE 388 ON READER SERVICE CARD

EQUIPMENT

UHF TV Rebroadcasting. Adler Electronics, Inc., 1 Le Fevre Lane, New Rochelle, N. Y. An illustrated 12-page brochure contains technical specifications and applications data on uhf tv translators (rebroadcast equipment) and associated uhf antennas.

CIRCLE 389 ON READER SERVICE CARD

Recording/Projecting Oscillograph. Microsound, Inc., 4627 Leahy St., Culver City, Calif. A brochure illustrates and describes Datascope, a recording/projecting

the Week

oscillograph which provides immediate viewing and a permanent record.

CIRCLE 390 ON READER SERVICE CARD

Digital Subsystems. Servomechanisms, Inc., 12500 Aviation Blvd., Hawthorne, Calif., has published a 4-page illustrated folder on functionally packaged digital subsystems.

CIRCLE 391 ON READER SERVICE CARD

Microwave Stability Tester. Pitometer Log Corp., 237 Lafayette St., New York 12, N. Y. A 4-page illustrated brochure covers the Pitlog series 800 stalo tester.

CIRCLE 392 ON READER SERVICE CARD

Automatic Spectrometer. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio. Form 3029-9 is a technical brochure on the recently announced print-and-plot gamma ray spectrometer.

CIRCLE 393 ON READER SERVICE CARD

Plastic Welding Equipment. Laramy Products Co., 90 South St., Hingham, Mass. Literature and price lists on the revised model plastic welding equipment are available.

CIRCLE 394 ON READER SERVICE CARD

Instruments. Southwestern Industrial Electronics Co., 10201 Westheimer Road, Houston 27, Texas. A one-page brochure includes photographs of and specifications for a transistorized voltmeter, transistorized signal generator, vibration meter, vtvm, audio response plotter, d-c amplifier, and micro-source.

CIRCLE 395 ON READER SERVICE CARD

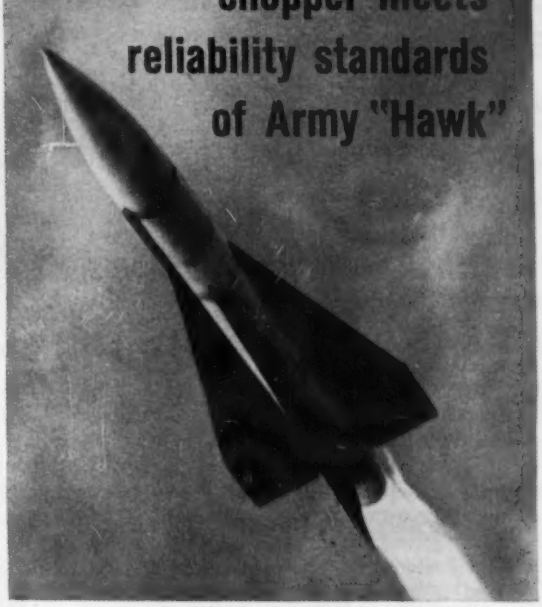
FACILITIES

Component Manufacture. Skysweeper, Inc., McHenry, Ill. A brochure entitled "This Business of Component Manufacture" details the company's methods of working with its customers, and outlines its facilities in design help, pilot models, engineering and production for all branches of the electronic field.

CIRCLE 396 ON READER SERVICE CARD

BRISTOL

chopper meets reliability standards of Army "Hawk"



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Every part that goes into a modern-day missile system must pass a rigid battery of tests and a thorough statistical screening to insure highest possible reliability in action.

That's why we're pleased to announce that Bristol Syncroverter choppers play an important role in guidance of the U.S. Army HAWK missile, produced by Raytheon Company, Waltham, Mass., prime contractor for the complete HAWK weapons system.

Billions of operations. Bristol Syncroverter* choppers are ideal for applications requiring the utmost in statistical reliability. The Bristol life-test lab has now had miniature Syncroverter choppers running for years without failure—both with and without contact load. Just one sample: five choppers with 400-cycle drive and 12v, 1ma, resistive contact load have completed 26,000 hours (2.96 years) continuous operation—over 37-billion operations!

actual size

An extremely wide variety of standard models is available—including external coil low-noise types. For complete data, write: Aeronautical Components Division, The Bristol Company, 152 Bristol Road, Waterbury 20, Conn.

*T. M. REG. U. S. PAT. OFF. 9.26

BRISTOL FINE PRECISION INSTRUMENTS FOR OVER SEVENTY YEARS

Litton: Two New Buildings

IN CANOGA PARK, Calif., Litton Industries recently opened two new buildings to house specialized research, development and manufacturing operations in military tactical systems.

The new facilities are situated on a seven-acre plot of ground, and the two single-story buildings are air-conditioned throughout. A multiple heat pump system operates through a new type of ceiling material. Integrated lighting systems are installed throughout both plants.

The Tactical Systems Laboratory of Litton's Electronic Equipments Division moved into the 100,000-sq-ft facilities to continue work on highly classified contracts.

Henry E. Singleton, Litton vice-president and division general manager, said at the formal opening that this move is the third major expansion in less than two years for the Electronic Equipments Division.

He said a major reason for the San Fernando Valley site choice was the availability of good living facilities for the rapidly growing staff, more than one-third of whom are engineers and scientists. In addition, he predicted the area would soon become the new electronics center of the U. S.

Norman H. Enenstein, new director of the Tactical Systems Laboratory, said: "This is an integrated engineering organization having facilities and experienced personnel for pursuing all phases of tactical systems engineering, from the analysis of mission requirements to in-plant system test and evaluation. This department today employs 500 engineers and scientists—and shortly we will have doubled that staff."

Hoffman Names Senior Engineer

PAUL S. K. CHEN has been appointed a senior engineer by the Semiconductor Division of Hoffman Electronics Corp.

Assigned to the division's fabrication unit, Chen will be responsible for the development of new diffusion techniques. He will be located at the division's new West Coast facility in El Monte, Calif.

Chen comes to Hoffman from the Heavy Minerals Co., Chattanooga, Tenn., where he was a research chemist.

Sarkes Tarzian Hires Brown

TOM BROWN, former vice-president of Oxford Electric Corp., Chicago, is now sales manager for the new Magnetic Tape Division of Sarkes Tarzian, Inc., Bloomington, Ind., manufacturer of tv and f-m tuners, silicon and selenium rectifiers, air trimmers, and broadcast equipment.

Rogers Joins Collins Radio

PHIL H. ROGERS has joined the Cedar Rapids Division of the Collins Radio Company, as assistant director of research. His responsibilities include circuit investigation and mathematical analysis throughout the range of communication frequencies. From 1956 to 1959 he was professor of electrical engineering at the U. of Arizona.

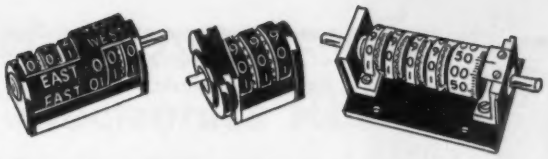
Rogers previously worked at the Sylvania Electronics Defense Laboratory, and as assistant professor of electrical engineering and a consultant to the Electronics Defense Group at the U. of Michigan.

Melpar Promotes K. E. Schreiber

MELPAR, INC., Falls Church, Va., recently promoted Kenneth E. Schreiber to manager of the Columbia Pike production department. He was formerly assistant to the manager of the production division.

Schreiber joined Melpar as a senior engineer in 1952 and was promoted to project engineer about a year later. In 1956 he became a section head and two years later was made assistant to the manager of the production division.

Melpar, Inc. is engaged in re-



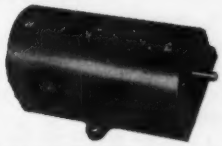
PRECISION COUNTERS

ALL TYPES • ALL SIZES ALL QUANTITIES

BY BOWMAR

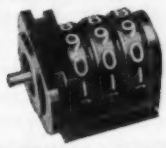
Bowmar designs and produces all kinds of precision counting and indicating devices to all specifications for all indicating applications. A few general types offered include heading and azimuth, latitude-longitude, decimal and impulse counters as well as unlimited special designs. Although Bowmar has standardized dozens of counting devices, all may be modified for new requirements. Counting configurations, light weights, small sizes, high speeds and special mounting hardware are among many factors which can be varied to accommodate new needs.

ANGLE COUNTER 1503. Counts from 000.0° to 359.9° and returns to 000.0; Input speed: 1800 rpm max. int., 500 rpm cont.; Weight: 2.5 oz.; O.D.: 1.310 in. Typical of many Bowmar designs currently being manufactured.

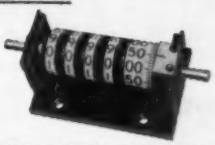


LONGITUDE COUNTER 2216. Provides true indication of longitudinal position; Input speed: 1000 rpm max. int., 300 rpm cont.; Weight: 6.1 oz.; Length: 2.87 in. Typical of many Bowmar designs currently being manufactured.

MINIATURE LATITUDE COUNTER 2417. Counts from 00°00'N to 90°00'N or S, with permissible overrun of 10°; Input speed: 1500 rpm max. int., 500 rpm cont.; Weight: 1.5 oz.; Length: 1.59 in. Typical of many Bowmar designs currently being manufactured.



MINIATURE DECIMAL COUNTER 2416 (with servo type mounting). Counts from 000 to 999 with return to 000. Input speed: 1500 rpm max. int., 500 rpm cont.; Weight: .5 oz.; Length: .685 in. Typical of many Bowmar designs currently being manufactured.



SPECIAL DECIMAL COUNTER 2660. Counts from 000000 to 999950 with return to 000000, in 50-unit increments. Input speed: 1000 rpm max. int., 300 rpm cont.; Weight: 3 oz.; Length: 2.33 in. Typical of many Bowmar designs currently being manufactured.

SEND NOW FOR DATA PACKAGE NO. 1258, WHICH DESCRIBES COUNTING DEVICES ABOVE IN DETAIL

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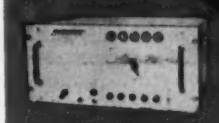
MEGACYCLE MICROSECOND COUNTER-TIMER MODEL 1001

The Universal Counter-Timer measures: Frequency from 0 to 1,000,000 cycles per second — Time intervals from 1 microsecond to 10^7 seconds — One or ten periods from 0 cps to 1,000,000 cps — Phase Angles from 0 to 360° — Ratio of two external frequencies. Ideal all-purpose counter.

100 KC FREQUENCY COUNTER MODEL 1010

This high speed electronic counter is combined with an accurate time base to provide an IN-LINE indication of frequency from 0 to 100,000 cps and periods from 10 microseconds to 10^2 seconds. It is ideal for use as an electronic tachometer, or a multi-purpose laboratory instrument.



TELEMETERING COUNTER MODEL 1043

Specifically for measuring subcarrier frequencies in IRIG FM/FM telemetering, Model 1043 also serves as a frequency counter for precise low frequency measurements. Features a normalized count of 20,000 in 1/5 second for each of 18 IRIG channels and a period selection up to 100,000 for low frequency measurements.

NUCLEAR SCALERS SERIES 1001

Where Reliability is the prime factor the one microsecond pulse paired resolution scalers offered will solve all applications. Predetermined count and/or time are offered as standard options.

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SUB-MINIATURE switches

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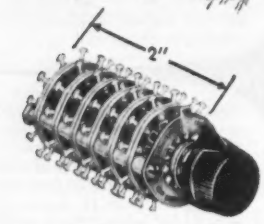
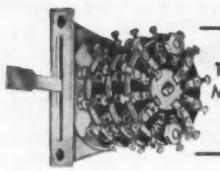
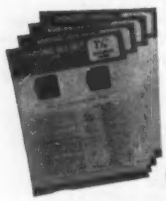




Ideal in miniaturized and transistorized test, communication and control equipment, this complete line of low-resistance switches provides maximum performance, requiring minimum space. Quality construction throughout . . . features silver alloy, double-wiping contacts, wafer of plastic material with high insulation resistance. Rotary Switches are available in shorting or non-shorting type. Series 7000, 1 to 6 decks . . . up to 12 single pole positions per deck . . . Series 5000, 1 to 4 double decks (2 wafers per deck) up to 11 single pole positions per wafer . . . positive detent mechanism. Both types also available with spring return. Lever Switches, with or without spring return, single or double throw types, available with 1 to 6 decks.



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search, development and production of electronic equipment for government and industry.

Motorola Hires C. F. Jefferson

CLINTON F. JEFFERSON has joined the Motorola Military Electronics Division, Phoenix, Ariz., as senior engineer in the materials laboratory of the Solid State Electronics Department. He will be concerned largely with research and development of magnetic oxide materials, and will contribute to the expanding line of solid state materials now being marketed by the company.

Jefferson was engaged in the magnetic oxide materials area as a research associate at the University of Michigan from 1953 until joining Motorola.

News of Reps

The Daven Co., Livingston, N. J., has appointed the **M. A. Stolaroff Co.** of Los Angeles, Calif., as its rep in southern California and Arizona on its complete line of rotary tap switches, precision wire wound resistors, transistorized power supplies, miniature switches, hermetically sealed metal film resistors, attenuators, LC filters, RC and resistive networks and laboratory test equipment.

Electronics Division, Elgin National Watch Co., has appointed **Murphy Associates,** Minneapolis, Minn., as sales reps in Minnesota, North Dakota, and areas of Iowa,

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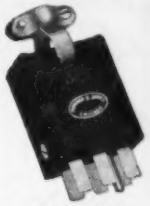

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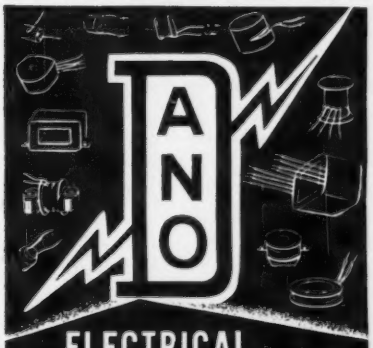

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Montana, Michigan and Wisconsin. Murphy will represent the entire line of Elgin-Advance industrial and military type relays and other electronic products manufactured by the division.

Appointment of the **Carey-Wolf Co.**, Fort Worth, as southwest sales rep is announced by Assembly Products, Inc., Chesterland, Ohio. Territory includes Texas, Oklahoma, Arkansas, and Louisiana.

Polyphase Instrument Co., Bridgeport, Pa., appoints the **J. S. Kempf Co.** of Inglewood, Calif., as west coast sales rep for the sales of its pulse and specialty transformers, electrical wave filters, and associated magnetic electronic components.

The **Wayne Beitel Co.**, Detroit, Mich., has been appointed factory sales rep for the Michigan area for Steelman Phonograph & Radio Co., Inc., Mt. Vernon, N. Y.

Daystrom Pacific, Los Angeles, Calif., adds four new sales rep organizations to cover 15 eastern states. Sales organizations and their territories are:

E. C. Raymund & Associates of Madeira Beach, Fla., to cover Florida; **L. L. Schley Co.** of Watertown, Mass., to cover the five New England states and Connecticut (except for Fairfield County); **QED Electronic Sales, Inc.**, of Mt. Vernon, N. Y., to cover greater New York City and adjacent counties, including northern New Jersey and Fairfield County, Conn.; and **Paul Hayden Associates** of East Point, Ga., to cover Alabama, Georgia, North Carolina, South Carolina, Tennessee and Virginia (except for Arlington County and the cities of Alexandria and Falls Church).

Power Sources, Inc., Burlington, Mass., manufacturer of transistorized power supplies, appoints **Deveer Sales Engineering Co.** of Needham, Mass., as industrial sales rep for the six New England States, excluding Fairfield County, Conn. Previously this territory has been covered by the P. J. Engineering Co.

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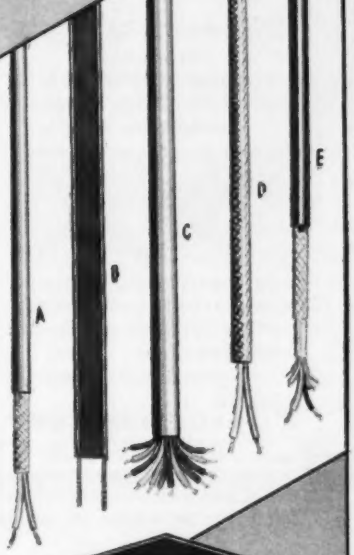

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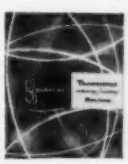

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COMMENT

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Your article "UK Presses Nav-Aid Fight" (p 29, May 22) left me just a bit wanting for details of American vs. British systems of air navigation aids.

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We have proposed a nondirectional sync signal, to be displayed as a vertical or horizontal electronic cross-pointer (or other) indicator on a cathode-ray tube on the planes. This sync signal is generated as the result of the movement of a narrow-width (2-deg) beam that scans in azimuth and elevation. Both waves are received on the plane. They are displayed on the scope before the pilot to indicate absolute information, since the movement of the scanner also keys itself and interrupts or modulates itself to provide the course and vertical glide-path indications.

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This vertical scope indication, after takeoff and until time to land, is utilized in combination for visual block signaling, using the same nondirectional sync signals sent out on long-wave channels. This would be

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Solecisms

I find your magazine a most informative and readable journal, and I suppose this indicates a competent staff. It seems too bad, then, that you—like the publishers of most other technical and nontechnical magazines—are so careless about grammar. I have come, regretfully, not to expect much from the engineer-writer; but I do think I should be able to expect more of editors.

One of the common errors today arises from the emergence of the word *comprise* into common usage—but by a recent count I made, four times out of five incorrectly! Contrary to popular usage, the components do not comprise the assembly, the assembly comprises—that is, consists of—all its components. I don't know whether or not ELECTRONICS has been passing this error; but if it hasn't, it's an exception.

The ubiquitous Latin nouns *datum-data, phenomenon-phenomena, criterion-criteria,* etc., are frequently abused, two of them quite prominently in your Sept. 18 issue. I suppose I should be resigned to "the data . . . is" by now, though I'll never like it; but I see no excuse for "criteria . . . is," used twice in large type on p 46 of the same issue!

I say let's keep the content of technical articles uppermost; but since all published writing does serve as a guide to usage, let's be sure we're presenting good examples.

U. L. UPSON
RICHLAND, WASH.

We agree wholeheartedly with reader Upson. We'd like to point out that criterion and phenomenon are both Greek, not Latin, nouns—while another editorial bete noir, medium-media, is Latin. Comprise is one of our pets; it's directly related to comprehend, if that's any help to anybody.

CHAREST

RESUME:

Charest, Roland J., Boston University, BS in Journalism. Formerly New England editor for **electronics.** Navy sonarman. Writer, reporter, editor for Lynn Item, Boston Globe, Boston Traveler. Won a New England Associated Press (AP) award in 1955 for writing feature articles in the major city newspaper class.

PRESENT OCCUPATION:

Rolly Charest supports Managing Editor Jack Carroll for editorial content accuracy and expediting putting each weekly issue to bed. Rolly reworks headlines for greater readability, is involved in makeup, and helps polish editorial content. Rolly's across-the-board background assures you accuracy in the face of journalistic pressures; articles in this week's issue that could be held over to the next deadline, but are not. The readers' interests come first!

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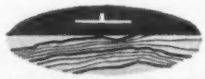
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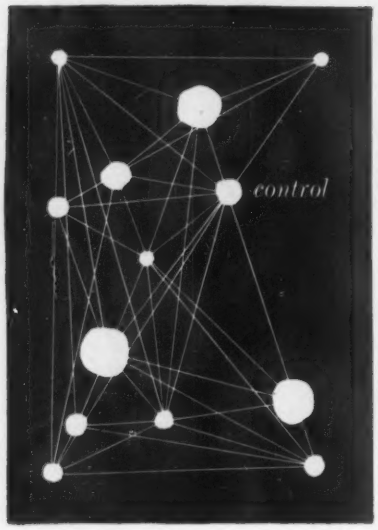

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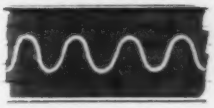
the satellite reports scientific data back to earth. **At the ground station, special communications equipments receive and demodulate space telemetry signals.**  **A data processing system analyzes findings which are fed in turn to the satellite control network and the computer memory banks, increasing man's knowledge of his newest frontier.**

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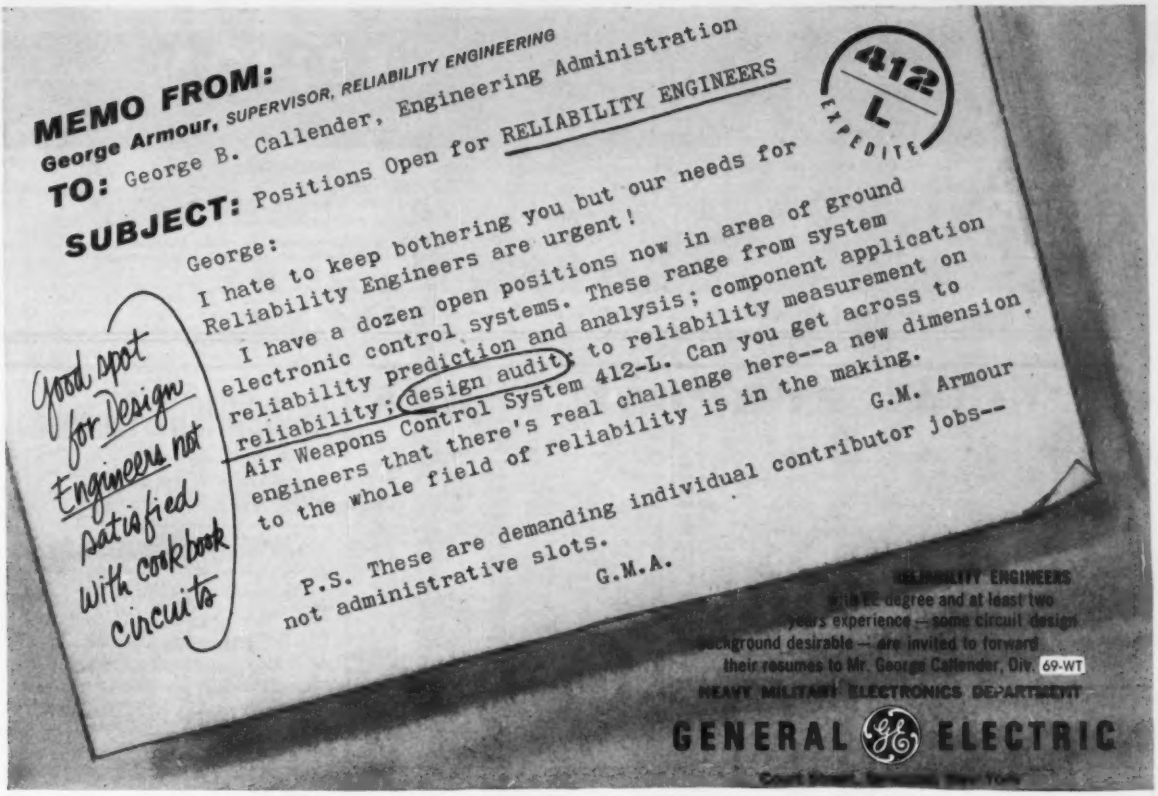
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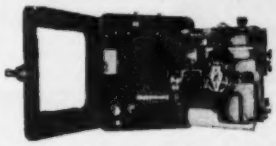

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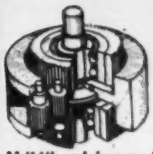

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Stock no. A6-115.....each $15.00

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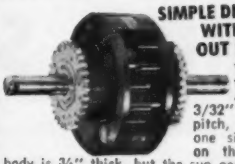

1:1 reverse ratio spur gears are aluminum, 3/32" face, 32 pitch, 32 tooth on one side, 48 tooth on the other. The body is ¾" thick, but the sun gears are spaced out so that they are 1½" apart. ¼" dia. shaft on each side is 23/32" long. OA length 3⅛". Requires 1-23/32" dia. to clear the body.
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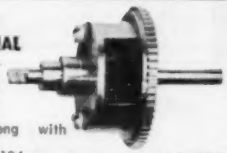

1:1 reverse ratio, 60 teeth on large gear; ¼" shaft. Size: 3" long with 1-15/16" dia.
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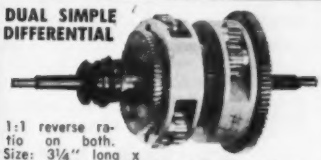
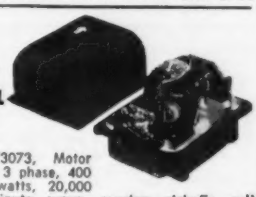
DUAL SIMPLE DIFFERENTIAL



1:1 reverse ratio on both. Size: 3¼" long x 1-7/16" dia. Shaft size: ⅛" and 5/32".
Stock no. A6-107.....each $7.50

SPERRY VERTICAL GYRO



Part #673073, Motor 115 volts, 3 phase, 400 cycle, 8 watts, 20,000 RPM. 3-minute runup, synchro pickoffs, roll 360°, pitch 85°. Synchro excitation 26 volts, 400 cycle, 150 m.a. Vertical accuracy ±½°. Weight 3½ lbs. Approx. dim. 5¾" L., 4½" W., 4½" H.
Price $35.00

MINNEAPOLIS-HONEYWELL RATE GYRO (Control Flight)

Part no. JG7005A, 115 volts A.C., 400 cycle, single phase potentiometer take off resistance 530 ohms. Speed 21,000 r.p.m. Angular momentum 2½ million, CM²/sec. Weight 2 lbs. Dimensions 4-7/32 x 3-29/32 x 3-31/64.
Price $22.50

VARIABLE SPEED BALL DISC INTEGRATORS

(All Shafts Ball Bearing Supported)

No. 145 Forward & Reverse 2¼-0-2¼. Input shaft spline gear 12 teeth 9/32" dia. ⅜" long. Output shaft 15/64" dia. x 15/32" long. Control shaft 11/32" x ⅜" long. Cast aluminum construction. Approx. size 3" x 3" x 2¾".....$17.50

No. 146 Forward & Reverse 4-0-4. Input shaft 5/16" dia. x ¾" long; Output shaft 15/64" dia. x 9/16" long. Control shaft 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4½" x 4½" x 4". **$18.50 ea.**

SMALL DC MOTORS

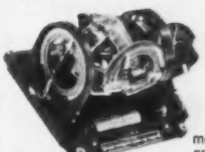
(approx. size overall 3¾" x 1¼" dia.:)

5067043 Delco 12 VDC PM 1" x 1" x 2", 10,000 rpm. $7.50
5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled 15.00 ea.
5069600 Delco PM 27.5 VDC 250 rpm 12.50
#5069625 120 rpm, mfr. Delco, 27 VDC governor controlled $15.00
5069230 Delco PM 27.5 VDC 145 rpm 15.00
5068750 Delco 27.5 VDC 160 rpm w. brake 6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2") 5.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled 15.00 ea.
#5069800 575 rpm, mfr. Delco, 27 VDC, PM reversible governor controlled, equipped with 27 VDC clutch $17.50
5072735 Delco 27 VDC 200 rpm governor controlled. 15.00
5BA10A118 GE 24 VDC 110 rpm 10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible 10.00
5BA10AJ52 27 VDC 145 rpm reversible 12.50
5BA10AJ50, G.E., 12 VDC, 140 rpm 15.00
5BA10FJ401B, G.E. 28 VDC, 215 rpm, 10 oz. in., .7 amp. contains brake 15.00
5BA10FJ421, G.E. 26 VDC, 4 rpm, reversible, 6 oz. in., .65 amp 15.00

SILICON RECTIFIERS

1N1454 25 amp. 100 volts $3.00
1N1455 25 amp. 200 volts $3.50
1N1456 25 amp. 300 volts $4.00
1N1457 25 amp. 400 volts $4.50
1N1451 5 amp. 200 volts $1.25
1N1452 5 amp. 300 volts $1.50
1N1447 .750 amp. 200 volts .75
1N1448 .750 amp. 300 volts .85

HONEYWELL VERTICAL GYRO MODEL JG7003A-1



115 volts, 400 cycles, single phase, 35 watts. Pitch and roll potentiometer pickoffs 890 ohms, 40 volts max. AC or DC. Speed 20,000 rpm, ang. momentum 12,500,000 gm-cm²/sec. Erection system 27 VAC, 400 cycles, time 5 min. to ½°.
Weight 5.5 lbs. Price $35.00 each

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Same high quality regulator in 10 AMP. size. Housed in beautiful steel cabinet with 0-150 meter, dual receptacle, fuse, switch, & heavy duty line cord. Ready for instant use. Wt. 19#. Priced at only $42.50.

Sola Constant Voltage Transformers

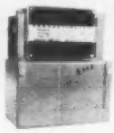
CLOSE OUT SPECIAL!

Pri: 183 to 224V 60cy. Sec: 105V at 4.8 A. Wt. 50#....Price $45.00	Pri: 104 to 126V 60cy. Sec: 6.3V at 75 A. Wt. 19#....Price $65.00

Veeder ROOT Electrical COUNTERS

Six digit, knob reset for base mounting. Can be used for many applications requiring quality at a low price. Form 8-124806 COIL: 28V DC—8 watts or 115V 60cy Wt. 1½#.....Price $9.95

DURANT PRODUCTIMETER

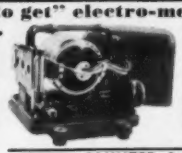


"Automation in a Small Package" Automatic Preset Counter Performs 4 operations:
(1) Operates as a high speed, 5 digit, electric counter from either 24V DC or 60V AC.
(2) Operates 8PDT switch when a preset 5 digit number has been reached.
(3) Resets by 115V-60cy. motor. A momentary switch or the preset switch will automatically complete this operation.
(4) The motor may be stopped at zero AUTOMATICALLY by a cam operated, SPDT, adjustable switch. This switch will also re-cycle, operate an indicator, or start another operation, if desired. Designed for panel mounting. Max. dim. 5"Wx2½"Hx5¼"D. Weight 4½#. Priced at only $95.00.

Coleman DIGITIZER Model A5DU-S6

Complete with Amphenol cable harnesses
Weight 3¼# Price: $365.00

M-H RATE GYRO



Stk. No. JG7005A11, Ser. 6. Operates from 115V-400 cy. at 21,000 RPM; built-in position pot. (530Ω); SPDT centering switch; circuit in cover; approx. 4" cube. Wt. 2#. Price $22.50

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Bodine NCI-33 precision capacitor motor. Speed change with simple DPDT switch. Dual shaft with one end ground for tape. Your choice 3⅝ & 7½ or 7½ & 15 I.P.S. 115V-60cy.-1/20HP-540/1080 RPM Wt. 7#. Price, motor only $14.50

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Plastic battery cases may have slight cracks-repaired easily or add 25¢ to price to insure uncracked case. *All cells guaranteed or money refunded (less postage).*

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Transmitter T67/ARC—complete **$45.00**
J68/ARC-3 Power supply with 2 motors .. **$35.00**
C 118/ARC-3 push button control .. **$4.50**

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R5/ARN-7 Receivers 100-1700 KC 25.00

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With 5 tuning units 38 to 4000 MC. $389.50

Excellent condition.

Write for prices on tuning units only.

Just received 12 RDO's in good condition at above prices.

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Ideal for radar, color TV, pulse and lab use. Video response to 7 mc at 3 db down, 10 mc at 6 db down. Stable triggered sweep, adjustable precision sweep delay. Crystal controlled marker generator with built in divider chain. Marker pulses and trigger pulses available at front panel. Beautifully built. Designed by M.I.T. Radiation Labs. Fully described in "Electronic Instruments" Vol. 21, Radiation Labs Series. Weight 150 lbs. Good condition. Govt. acquisition cost $1700. Your cost only $99.50.

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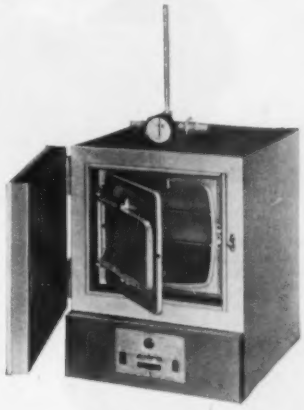
A vacuum oven combining large capacity, high temperatures and new convenience with modern styling has recently been introduced. Designed to meet a variety of tasks including semiconductor testing, missile component testing, paraffin embedding as well as anaerobic incubation, the oven offers the following features:



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The 1½ cubic foot capacity vacuum chamber contains two 12″ x 17″ shelves to allow increased sample capacity. A new electronic control system and improved construction allow the temperature to be increased to 22° C with a uniformity of ± 2.4° C at maximum temperature.

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In addition to vacuum testing, the oven may be used at pressures up to 2 psi to permit sample testing under any atmosphere. Provision is also made to bring electrical leads directly into the vacuum chamber after a slight alteration.

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Convenience features include a temperature selection dial calibrated directly in C and F, a protective outer door to minimize heat loss, a vacuum chamber door permitting one hand operation and a combination vacuum-pressure gauge.

Full details on the Model 524 Freas Vacuum Oven and other Freas ovens can be obtained through your local distributor or from Precision. Ask for Bulletin 302.

Precision Vacuum Pumps are ideal companions for this Vacuum Oven. Bulletins 604 and 607 offer complete pump information.

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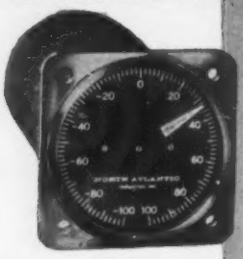
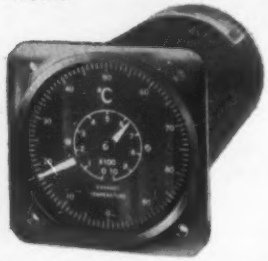


SERIES 200 SINGLE POINTER INDICATOR
For applications requiring accuracies and resolutions of less than .2% and high speed of response.



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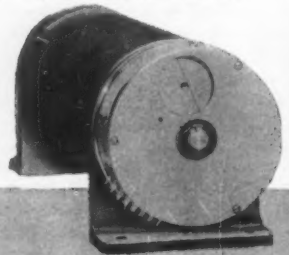
For highest accuracy and resolution.



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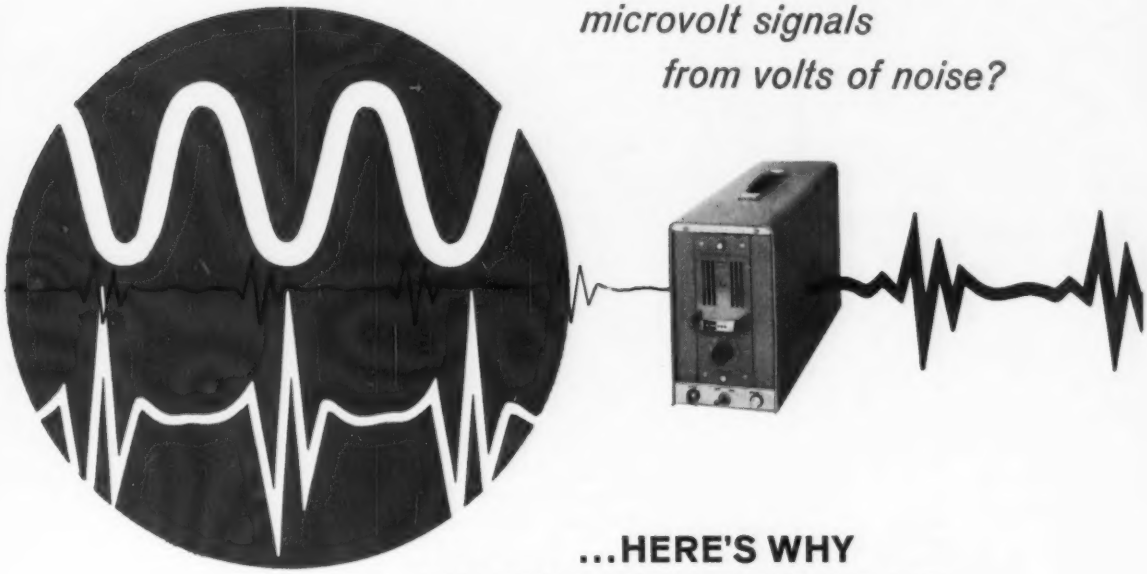
Puzzled by ground loop problems? How to rescue microvolt signals from volts of noise?



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180 db DC, 130 db 60-cycle common mode rejection with balanced or unbalanced input • Input completely isolated from output • Input and output differential and floating • 5 microvolt stability for hundreds of hours • .05% linearity, 0.1% gain stability • Gain of 10 to 1000 in five steps • $>$ 5 megohms input, $<$ 2 ohms output impedance • 100-cycle bandwidth • Integral power supply

These are just a few of the many outstanding features of the Model 114A differential DC amplifier...features that make this amplifier *really work* in instrumentation systems...features that will help solve *your* instrumentation problems today.

Ideal for thermocouple amplification, the 114A eliminates ground loop problems; allows the use of a common transducer power supply; permits longer cable runs; drives grounded, ungrounded or balanced loads; can be used inverting or non-inverting. Price $875.

For additional information and technical literature on this exceptional instrument, write or call KIN TEL—the world's largest manufacturer of precision, chopper-stabilized DC instruments.

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November 17-19

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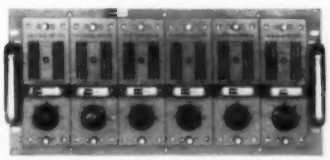

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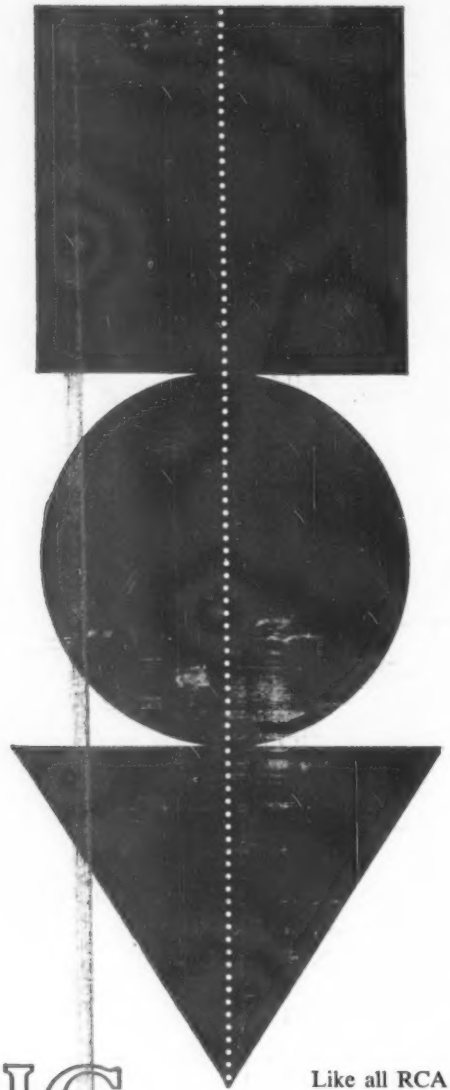

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RCA-12DT8

Take for example RCA-12DT8, the designer-preferred twin triode for rf amplifier and combined oscillator-mixer service in 5-tube FM and low-cost AM-FM receivers.

Like all RCA Preferred Tube Types, RCA-12DT8 offers outstanding uniformity of electrical characteristics, top performance, and excellent availability. Volume production and a program of continuous evaluation also bring new improvements to this type. For instance, frequency stability has been improved and microphonics reduced by the use of a new and more rigid grid wire. And the possibility of heater-to-cathode shorts and heater burnouts has been minimized due to an improved heater wire.

So call your RCA Field Representative and ask him for complete information on the Preferred-Type Tube that's basic to good design—RCA-12DT8. Ask him too about RCA-6DT8.

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